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Issue 7

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NASA Contractor Report 3922(08)

USSR Space Life Sciences Digest

Issue 7

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* Topics marked with * have no entries of their own, but refer readers to relevant abstracts included in other topic areas.

FROM THE EDITORS

This is the seventh issue of the USSR Space Life Sciences Digest. Readers' attention is called to the two Special Feature interviews following the abstract section of this issue. These are a small sample of the types of articles which are appearing in great numbers to commemorate the 25th anniversary of Gagarin's flight and/or reflect public interest in the latest Soviet space exploits. Although primarily intended for life science researchers supported directly or indirectly by NASA, this Digest is available to everyone. Anyone wishing a subscription need only write to the address below to be put on our mailing list. Individuals receiving the Digest regularly who have no interest in continuing to do so are also asked to write to us at the same address. We welcome (and respond to) reader feedback of all kinds.

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ADAPTATION

(See also: Cardiovascular and Respiratory Systems: M81; Musculoskeletal System: P293; Neurophysiology: M85)

PAPER:

P303(6/86)* Alyakrinskiy BS.

Philosophical aspects of the theory of adaptation.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2):6-15; 1986.

[40 references; 1 in English]

Adaptation; Biological Rhythms

Theoretical Article

Philosophy, Dialectics

Abstract: This theoretical paper considers the process of biological adaptation in the context of the dialectical theories underlying Marxism [Hegel, Marx, Engels, Lenin]. This theory postulates that all development occurs through a process of thesis - antithesis- synthesis. Here, adaptation is identified with progression from the antithesis to the synthesis stage. If this process were not continually occurring, dialecticians claim, stagnation would result. Thus the imperative to adapt to adverse factors creates benefits for the individual organism, the species, and the biosphere as a whole. It is argued that circadian rhythms provide one of the most important mechanisms for adaptation, and thus, for dialectic development.

BIOLOGICAL RHYTHMS

PAPER:

P282(6/86) Krivoshchekov SG, Divert GM, Domakhina GM.

Mechanisms regulating muscle activity as a function of human biological rhythm type.

Fiziologiya Cheloveka.

12(2): 258-262.

[19 references; 3 in English]

Institute of Physiology, Siberian Department, USSR Academy of Medicine

Biological Rhythms, Typology; Human Performance, Work Capacity

Humans, Males and Females

Musculoskeletal System, Muscle Activity

Abstract: This study investigated the relationship between subjective (self) assessment of work capacity and electrical activity of muscles. A group of 10 men and 11 women (aged 25 to 35) served as subjects. Subjects were divided on the basis of biological rhythm type by a technique which apparently involved self-assessment. One of the men and two of the women were self-classified as "morning people," two of the men as "night people," while the remaining were considered "arhythmic." Measurements were made four to five times both in the morning (9:00 - 10:00) and evening (17:00 - 18:00). At these times, the subjects were required to perform graduated exercise on an ergometric bicycle for 3 minutes, pedalling at 60 rev/min. During this procedure, electrical activity of the muscles was determined using bipolar electrodes on the lateral head of the gastrocnemius muscle. The latency and duration of the H-reflex induced by electrical stimulation of the lateral cutaneous nerve of the thigh was also studied. It was found that for both the "morning" and "night" people, an increase in electrical activity of the muscles both at rest and during physical exertion coincided with the self-assessed period of maximum work capacity. [Note: these results are based on a total of only five subjects.] It was found that reaction time also coincided with these indicators for the different types. For the three "morning" subjects, H-reflex latency was lower in the morning than in the evening, but no comparable pattern was found in the "night" subjects. The authors conclude that: 1) There is a correlation between level of work capacity as estimated subjectively and functional activity of the muscles. This makes it possible to use functional activity of the muscles as an objective criterion of an individual's biological rhythm profile. 2) Fluctuations in subjectively assessed level of work capacity and of functional muscle activity in the waking state in "morning people" are synchronized with fluctuations in the functional state of the central nervous system and the peripheral motor subsystem to a greater extent than in "night people. 3) Physiological differences in the profiles of human biological rhythms are primarily determined by regulatory mechanisms in the central nervous system and, in the authors' opinion, are caused by phylogenetic traits for "morning" people, and by social rhythms for "night" people.

Table and Figure Titles; Table 1: Electromyogram and H-reflex parameters in the morning and evening for people of different biological rhythm types

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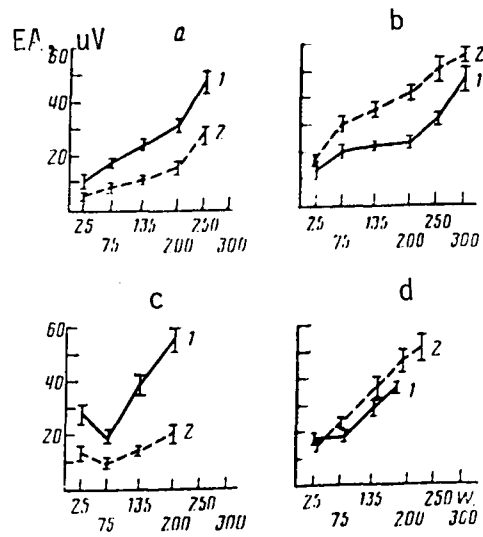


Figure: Electrical activity of muscles in the morning (1) and evening (2) in individuals of various biological rhythm types in response to incremental physical loading; a - morning type, males; b - morning type, females; c - evening type, males; d- arhythmic, females

BIOSPHERICS

MONOGRAPHS:

M77(6/86) Moyseyev NN, Aleksandrov VV, Tarko AM.
Chelovek i biosfera: Opyt systemnogo analiza i eksperimenty s modelyami
[Man and the biosphere: Case studies in systems analysis and simulation].
Moscow: Nauka; 1985.
[272 pages; 83 illustrations; 190 references; 102 in English]
Computer Center, USSR Academy of Sciences

Key Words: Biospherics, Anthroprogenic Effects, Nuclear War, Climate,
Biogeochemical Cycles; Mathematical Models, Simulations

Annotation: This book is based on papers which were presented at
international seminars in Finland, Italy and the United States concerning
the problems of the coevolution of man and the biosphere and the possible
consequences of a nuclear conflict.

This book is intended for scientists working in the area of applied
mathematics, also for biologists, and for specialists in the area of
environmental protection.

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M82(6/86) Vinogradov BV.

Aerokosmicheskiy monitoring ekosistem

[Aerospace monitoring of ecosystems].

Moscow: Nauka; 1984.

[320 pages]

Section on the Chemical Engineering and Biological Sciences, USSR Academy of Sciences, Soviet Committee for the UNESCO "Man and the Biosphere" Program

Key Words: Biospherics, Aerospace Monitoring, Remote Sensing, Vegetation, Soil, Wildlife, Ecosystems, Nature Preserves

Annotation: This book synthesizes research on aerospace monitoring of indicators of the status of vegetation, soil and wildlife, along with remote sensing measurement of major parameters of ecosystems: phytomass and vegetation cover, moisture and humus content of the soil. A theory of sensing is presented which includes methods for classifying, extrapolating and evaluating remote sensing data. The use of remote sensing photographs for studying the structure and seasonal dynamics of ecosystems, as well as ecological forecasting, are discussed. The book concludes with a discussion of remote monitoring of biospheric preserves. This book is intended for a wide range of biologists, ecologists, biogeographers and engineers.

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M83(6/86) Vladimirovskiy BM, Kislovskiy LD.
Kosmicheskiye vozdeystviya i evolyutsiya biosfery
[The influence of space on the evolution of the biosphere.]
Part of popular series: Kosmonavtika, Astronomiya
Moscow: Znaniye; 1986.
[64 pages]

Key Words: Biospherics, Evolution of the Biosphere, Space Factors,
Anthropogenic Effects, Ecology; Radiobiology

Translation of concluding chapter, "The Biosphere and Space," pp. 59-64.

The time has come for conclusions. Until very recently the great majority of modern scientists believed that all large-scale processes occurring on Earth are completely autonomous, not subject to any interference from space factors. It was previously presumed (or more accurately, postulated), that the stable evolution of the biosphere undoubtedly implied a high degree of stability in ecological conditions on Earth over a period of at least 3 billion years. This constancy in ecological conditions, in turn, presupposes that the parameters of Earth's space environment are immutable.

This traditional point of view was summarized by the famous paleontologist and science fiction writer I. Ye. Yefremov (who was greatly interested in astrophysics) as follows:

"The continuity of historical development demonstrates beyond any doubt that living conditions on the surface of the Earth have been stable for an extremely long period of time, reflecting constancy of solar radiation and a state of equilibrium of the substances within the Earth's interior... It took approximately 400 million years for the first fishlike vertebrates to evolve into the higher life forms, such as mammals.

During this enormously long period of time the Sun never once "undermined" life on Earth. Similarly, the trillions of kilometers of galactic space traversed by our Earth, along with the rest of the solar system, never once lead to a fatal encounter." (Inhabited space. Moscow: Nauka; 1972, pg. 95).

A little over two decades ago, theoretical and observational data which substantially altered this thesis began to accumulate in the field of astrophysics. A new area of research opened up, under the rubric of "cosmic catastrophism." This term is not entirely appropriate since the effects of Earth's space environment on living conditions were far from catastrophic -- in the narrow meaning of the term -- in all cases, but, rather, involved gradual alteration of ecological conditions.

A summary of the results obtained in this research area is presented in Table 5. The effects of astrophysical phenomena marked "?" are highly problematic. It is not completely clear whether solar superflares occurred: it is not known whether nuclei explode in galaxies of our type. In all of the remaining cases paleoecological consequences on one scale or another are absolutely unavoidable.

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Dozens of times during the evolution of the biosphere, supernovas flared in close stellar proximity to our solar system. It is probable that the most common cause of changes in our living condition was the passage of the solar system through gaseous dust clouds. The nature and size of these paleoecological changes, however, are not completely clear. Only after special investigations applying models of contemporary climates to the paleoatmosphere can we hope to gain definitive insights into the reasons for the ice ages.

Astrophysical Phenomenon	Energy transfer $\text{erg} \cdot \text{m}^{-2}$	Ecological Change	Frequency of Occurrence
Large-scale variations in solar activity	--	Moderate climatic changes	?
Superflares?	10^8	Damage to ozonosphere -- increase in intensity of UV radiation, decrease in temperature	?
Long-term variations in solar constant	--	Ice ages	Once in 10^8 yrs
Explosion of galactic nucleus?	10^8	Gamma-impulse damaging ozonosphere and increasing intensity of UV and cosmic rays	Cycle in 10^7 yrs
Supernova flare at a distance of 10 pk	10^9	Gamma-impulse damaging ozonosphere and increasing intensity of UV and cosmic rays, decrease in temperature	Once in $3 \cdot 10^8$ yrs
Passage through molecular clouds	--	Climatic changes, introduction of organic compounds	Once in $3 \cdot 10^8$ yrs
Bombardment by asteroid sized bodies	10^{12}	Sharp increase, then drop in temperature, destruction of ozonosphere, dust in atmosphere	Cycle in 10^7 yrs

The bombardment of the Earth's surface with bodies the size of asteroids must be acknowledged to be the most impressive of these phenomena and is responsible for a major disruption of the Earth's ecological equilibrium. At present, both the nature and the origin of such bodies remains unclear. If sharp increases in the rate of disappearance of families of marine fossil organisms may be used as an index of the occurrence of critical moments in the evolution of the biosphere as a whole, then we must acknowledge that such episodes are a major reason for these evolutionary crises. There is also reason to assume that such episodes may be implicated in the extinction of the dinosaurs.

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However, we must still emphasize that the evolution of the biosphere was influenced primarily by terrestrial factors. It is incontestable that many of the most important stages in this evolution were precipitated by a combination of terrestrial factors and it is completely justified to consider many processes affecting evolution as autonomous processes. However, processes originating in space undoubtedly served to influence this evolution, in concert with terrestrial forces. At each stage of evolution, the ecological situation and the changes it underwent were determined by the inseparable combination of the effects of terrestrial and space factors. If the "cosmic component" of the causation of natural phenomena is neglected, the very concept of the evolution of the biosphere will become incomplete and one-sided.

Returning to Table 5, we can see that, in the majority of cases, the ecological changes boil down to "damage" to the ozonosphere and climatic variations. Thus, with certain exceptions, ecological disruptions precipitated by cosmic factors are not exotic, but "everyday" in nature. This is the reason for the obvious difficulty of identifying the "cosmic" component of such disruptions of ecological equilibrium. However, this "cosmic" factor absolutely must be included if adequate ecological models are to be developed.

Finally, we may note that astrophysicists, of course, would be very interested in knowing how frequently the solar system actually passes through dense clouds of interstellar matter. And if the Kleb-Hape?? hypothesis of the origin of the bombarding bodies is correct, we have material from very remote areas of the Galaxy right under our feet! For this reason, the further development of research on cosmic catastrophism is of unquestionable interest to astrophysicists.

Instead of a static and somewhat idyllic representation of the evolution of the biosphere, as sketched by I.A. Yefremov and cited above, we begin to see the outlines of a picture of evolution which is more complex (and thus more interesting). On one hand, some of the phenomena cited in Table 5 (and some purely terrestrial phenomena have to be added to these) must have been accompanied by extreme ecological consequences, not excluding, it would seem, the total destruction of the conditions needed for life. It looks as though the biosphere reacted to such episodes with changes in its species composition, at times major changes.

Such a reaction, evidently, may be considered to be a systemic response to the disturbance, analogous to the development of a "standard" stress response by an individual organism to an extreme situation (of whatever nature). On the other hand, ascending evolution continued uninterrupted and the most important ecological parameters never reached critical values. It is difficult to withstand the temptation to hypothesize the existence of a global homeostatic mechanism stabilizing these parameters within certain limits.

Such ideas have been discussed by a number of authors. For example, the Belorussian researchers V.B. Kadatskiy and L.M. Kagan propose that the biosphere supports climatic indicators on Earth in an optimal configuration, conducive to "normal" functioning. In their view, a decrease in

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the radiance of the Sun would give rise to changes in the conditions of life, which would facilitate an increase in the surface temperature of the Earth (and to the reverse, if radiance were to increase). Within the framework of this hypothesis, the ice age would correspond to a situation where the disturbance had a very high "amplitude" and the compensatory mechanism was not able to fully restore the optimal conditions.

A conception of the biosphere as a single cybernetic system with homeostatic properties is not universally accepted and may even seem extreme. But this is the case only at first glance. In any event, living matter, without a doubt, has "capabilities" which are fully adequate to implement this type of control. It has long been known that many important parameters of the atmosphere and the hydrosphere are determined through the direct participation of living matter in creating dynamic equilibrium.

The oxygen in the atmosphere is completely biogenic in origin and is fully renewed every several thousand years (carbon dioxide -- in only 6.3 years!). The total body of ocean water is filtered by plankton in a half a year (additional information of this type may be found, for example in [1]). If we consider the biosphere as a unified system actively reacting to external changes, in particular, opposing the effects of space factors, then the results of research on "cosmic catastrophism" do not seem at all paradoxical.

The hypothesis that the homeostatic mechanism we have discussed has developed in the course of evolution is completely reasonable. Using V. I. Vernadskiy's term, the biosphere of our time has already become a "noosphere", since all of its major parameters, all its most important dynamic capabilities, and the very responsibility for the existence of life itself, have begun to be determined by human civilization. What, in this case, will happen with the geohomeostatic mechanism, which has developed over the course of evolution?

It is in keeping with V.I. Vernadskiy's ideas that the scientific and technological potential of modern civilization is a component of this same homeostasis. In our time, humanity should be able to protect our beautiful planet from the appearance of a crater on its surface with a possible diameter of 100 kilometers. After all this would be the most irrevocable of all cosmic effects!

BODY FLUIDS

PAPER:

P305(6/86)* Grigor'yev AI, Verigo VV.

Mathematical modeling of the processes of fluid-electrolyte exchange.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2):24-27; 1986.

[12 references; 4 in English]

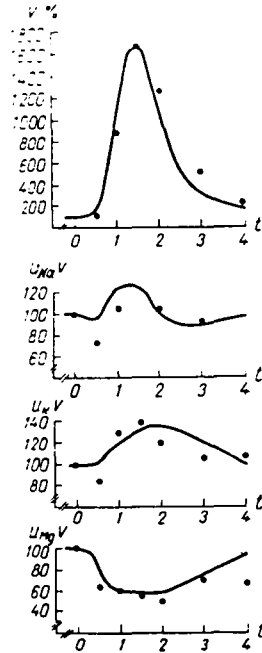
Body Fluids, Fluid-Electrolyte Exchange

Mathematical Model

Extreme Conditions, Provocative Tests

Abstract: The first Soviet simulation of fluid electrolyte exchange under extreme environmental conditions was performed in 1977 at the Institute of Biomedical Problems of the USSR Ministry of Health. The effort discussed in this paper began with the development of a model to simulate the reactions of the fluid electrolyte exchange system to provocative tests. A five-module representation of this process was developed including: central hemodynamics (sensitive to body position and information from baro- and hemo-receptors), renal hemodynamics (sensitive to blood proteins and nerve and humoral regulation), intravascular liquid, intracellular liquid and interstices. The internal structure of each of these modules was derived from an earlier model by Guyton et al. An important modification of the earlier model involves the introduction of equations simulating the transport of bivalent cations of calcium and magnesium, assuming a filtration rate proportional to their concentration in blood plasma. It is also assumed that the rate of reabsorption of these elements is a function of the concentration of bivalent cations, as well as of the osmotic concentration (mainly sodium and chlorine) in the plasma. The time required for rate of reabsorption to respond to changes in the osmoticity of the plasma is assumed to be about 3 minutes, while the time required for selective regulation of ion composition to adjust to changes in calcium and magnesium concentration is assumed to be one hour. The model, which is still under development, has yet to simulate the effect of ADH production on the volume receptors of the interstices, as well as the effect of plasma osmolarity on production of ADH. In addition, a number of the parameters must be fine tuned and other changes must be made. The model produces data which qualitatively replicates experimental data on human responses to provocative tests (e.g, responses to a water loading test during and after hypokinesia). Plans have been made to integrate this model with others, e.g., a simulation of fluid homeostasis being developed jointly with Czechoslovakian scientists. A distinguishing feature of the models being developed is the detailed analysis of the biomechanical characteristics within the veins and the interstitial medium. Plans are also being made to individualize model parameters in order to more accurately reproduce the data for a single subject or typologically distinct group.

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Figures: Figure 1. Simulation of the process of transport of fluid and electrolytes in response to a provocative tests. Curves are the functions obtained from the model. Dots are experimental data

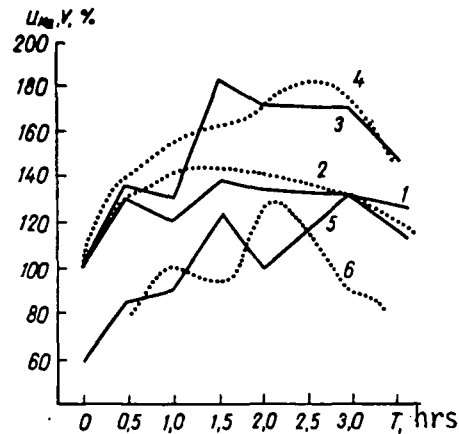


Figure 2: Simulation of excretion of sodium over time during and after a period of hypokinesia. 1 and 2 - baseline; 3 and 4 - day 2 of hypokinesia; 5 and 6 - day 2 after termination of hypokinesia; solid lines - experimental data; dotted lines - simulation data

BOTANY

(See also: Biospherics: M77; M82; Life Support Systems: P302; M78)

PAPERS:

P281 (6/86) Merkis AI, Laurinavichyus RS, Shvyagzhdene, DV.
Gravitational sensitivity and growth of plants in weightlessness
Izvestiya Akademii Nauk SSSR: Seriya Fizicheskaya
49(4): 715 - 723; 1985.
[33 references; 18 in English]

Botany, Growth and Tropisms, Viability
Lettuce, Sprouts; Arabidopsis, Seeds
Space Flight Conditions, Salyut-7; Artificial Gravity, Centrifugation

Abstract: This paper discusses the results of 2 experiments performed on board the "Salyut-7" station in 1982. The goal of the first experiment, which used a centrifuge on board the spacecraft, was to study the initial growth phase and tropic movements of lettuce sprouts under space flight conditions. In the first experiment, packets of lettuce (Lactuca sativa L.) seeds were housed in either the centrifuge or the stationary block of the "Biogravistat-1M" apparatus (See Digest Issue 4: P178). The centrifuge could be regulated to simulate gravity of 0.01-, 0.1-, or 1-g. Seeds, which had been air dried, were moistened after flight began. A ground (control) condition utilized the same device with the axis of the centrifuge in a horizontal position. Results of various gravitational forces on the ground and in space are depicted in Figure 1. In agreement with earlier experimental results, the axial organs of the ground controls grew to nearly twice the length of those in all the space flight conditions, although both had the same sprouting time (not specified). That the plants centrifuged in space were also shorter than the controls prevents simple attribution of the effect to microgravity. When plants in the flight stationary and centrifuged blocks were compared, it was found that, when the space centrifugation condition is taken as 100%, decrease in gravitational force led to an increase of 8-16% in hypocotyl growth, and a decrease in root growth of 17%. When tropic movements (spontaneous growth to the left and right of the axis line) were examined, it was found that variability in angle of deviation from the axis was almost four times higher in the space flight groups than in the ground controls (see Figure 1). When the space flight plants were considered as a whole, total deflections to the right were found to be equal to those to the left, although this was not the case for individual conditions which showed marked "preference" for one direction or the other. Centrifugation equivalent to 0.01-g during flight increased the mean angle of deflection by a factor of 3-5 over that in the non-centrifuged flight conditions.

In the Biogravistat-1M centrifuge block the seeds were oriented so that at the beginning of the experiment the angle between the long axis of the seed and the centrifugal vector was 90°. The seeds were placed so that the hypocotyls and roots could make geotropic deflections in response to the centrifugal force. Figure 3 shows the mean deviation for root and hypocotyl growth in all conditions. This figure shows the approximate equivalence of centrifugation of seeds in space and horizontal orientation of seeds on Earth. Figure 4 shows the angle of deviation of root and hypocotyl in the flight conditions as a function of artificial

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gravity. A linear correlation could not be established for roots, since the maximum effect, (equivalent to growth in horizontal position on the ground) was achieved at gravitational force of 0.1. This prevented the extrapolation of the threshold of sensitivity. For the hypocotyl a linear regression gave a better approximation of the data and was extrapolated to the null value for no geotropic response as $\sim 2.9 \cdot 10^{-3}g$.

In the second set of experiments, *Arabidopsis* plants were housed in the "Fiton-3" (cf. Issue 4; P178) apparatus. [Note: this appears to be the same study reported in abstract P235; however, the emphasis on results reported is different.] The seeds were sown after ascent into space. On day 69 after sowing, the experiment was terminated and the plants returned to Earth. Seven mature plants were obtained with dried leaf rosettes and green leaflets on their stems. On 5 of the plants, 22 normal pods had formed, approximately half of which were immature, and the remaining 2 plants bore only 11 sterile, seedless pods. In the ground condition, 8 of the *Arabidopsis* plants grew, with a total of 34 normal pods. Observation during growth showed that the flight plants developed more slowly than the controls, terminal stem length was shorter, and pods and seeds were smaller. However, it is not possible to attribute these quantitative changes to particular space flight factors. What has been demonstrated is that higher plants can be grown in space. The next step in the experiment involved determination of the viability of the seeds developed from the plants grown in space. Seeds from these and control plants were cultivated using traditional methods. When seeds from the first generation plants were mature, these too were sown and their growth and development was observed. Biometric data was recorded characterizing the germination, growth and fructification of the first and second generation flight and control seeds. Table 3 presents the results. Although first generation flight seeds differed in many parameters from control seeds, the only statistically significant difference involved the shorter hypocotyl and cotyledonous leaves of the offspring of plants flown in space. No differences were found in the second generation plants. The authors conclude that these experiments demonstrate that at least some plants which have been exposed to space are able to complete an entire cycle of growth and that at least some seeds produced by space-flown plants are biologically viable.

Table and Figure Titles: Table 1: Deviation from rectilinear growth of hypocotyls and roots of lettuce in weightlessness and centrifuged at 0.01-g (N - deviation, θ_{mean} - mean value of the angle of deflection)

Condition	Organ	#	Angle of Deviation		Mean Variance
			$N_{\text{min}} - N_{\text{max}}$	$\theta_{\text{mean}}, ^\circ$	
Weightlessness (Experiment 1)	Hypocotyl	181	-91 - 48	-5.8	23.1
	Root		-120 - 110	8.05	35.3
Weightlessness (Experiment 2)	Hypocotyl	198	-71 - 58	-6.63	21.4
	Root		-87 - 117	10.75	35.0
Weightlessness (Experiment 3)	Hypocotyl	97	-79 - 50	-1.40	25.0
	Root		-99 - 81	-1.72	36.3
Centrifugation, 0.01-g	Hypocotyl	134	-65 - 50	-11.93	20.8
	Root		-46 - 124	50.72	27.7

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Table 2: Comparison of morphological parameters of plants and seeds of Arabidopsis grown on the ground and on board the "Salyut-7" in the "Fiton-3" apparatus

Parameter	Control	Experimental
Number of surviving plants	8	7
Number of leaves in a rosette	7.5	5.8*
Height of plant, cm	17.5	9.6*
Length of mature pods, mm	7.51	5.2*
Length of seeds, mm	0.431	0.405*
Width of seeds, mm	0.265	0.244*

* Difference statistically significant, $p < 0.01$

Table 3: Growth and development of Arabidopsis plants in generations M_1 and M_2 grown from seeds developed under space flight conditions

Parameter	Control		Experimental	
	M_1	M_2	M_1	M_2
Number of seeds sown	71	35	69	37
Germination rate, %	87.3	97.1	72.4	100.0
Number of embryological deaths, %	22.5	4.8	42.0[sic]	2.3
Number of seeds with full biological value, %	67.6	94.3	42.0	94.6
Hypocotyl length, mm	4.19	5.85	3.27*	6.27
Length of cotyledonous leaves, mm	2.62	2.40	2.32*	2.45
Width of cotyledonous leaves, mm	2.59	2.74	2.40	2.81
Number of leaves per rosette	5.20	6.45	5.30	6.29
Height of the plant, cm	17.46	18.72	17.44	18.50
Number of pods on one plant	5.70	5.70	5.90	5.90
Number of seeds per pod	27.50	23.30	26.80	22.60

* Difference statistically significant $p < 0.01$

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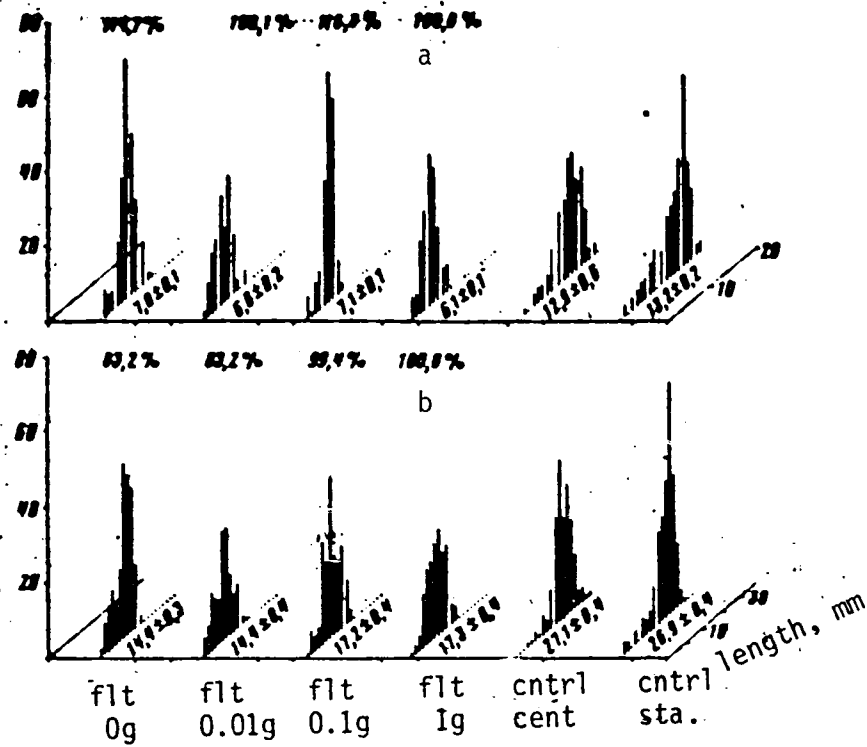


Figure 1. Histogram of distribution of hypocotyl (a) and root (b) lengths as a function of gravitational force

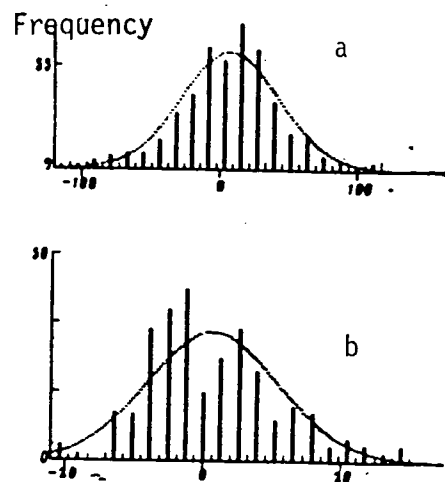


Figure 2. Histogram of the distribution of angles of deflection from the rectilinear direction in the roots of lettuce grown under weightlessness (a) and on the ground (b)

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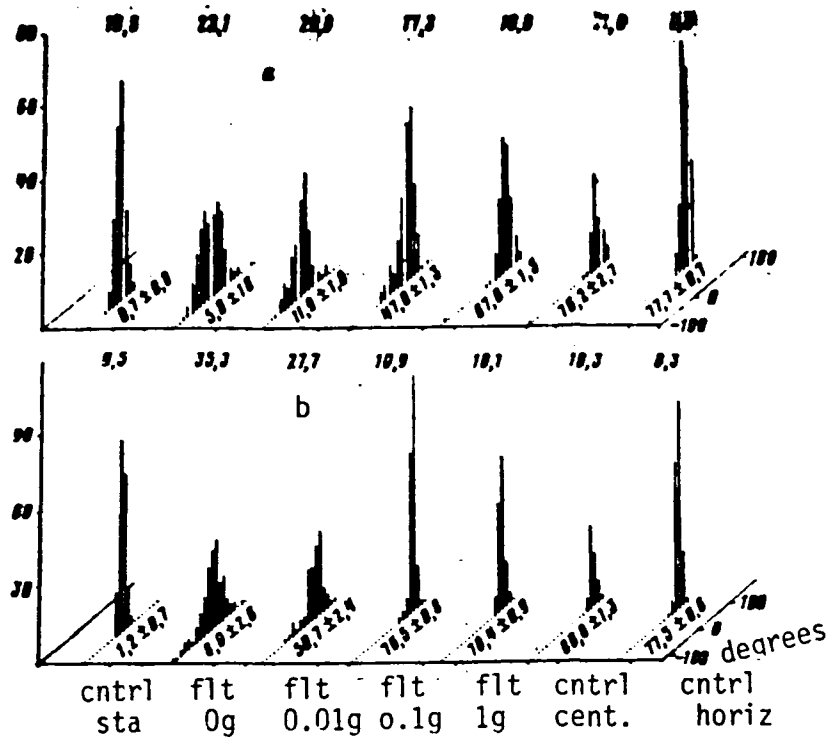


Figure 3: Deviation from rectilinear growth of hypocotyls (a) and roots (b) of lettuce as a function of gravitational force

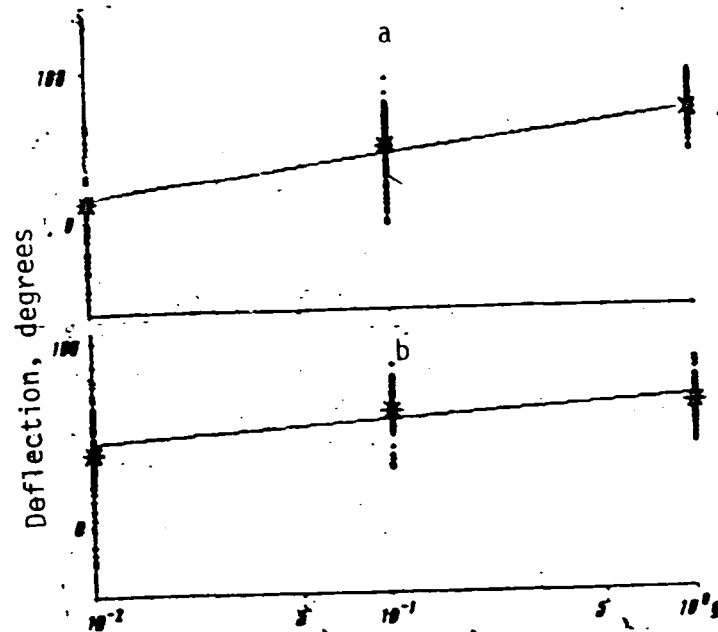


Figure 4: Angle of deflection of the hypocotyls (a) and roots (b) of lettuce as a function of gravitational force under space flight conditions: correlation coefficient: 0.755 for hypocotyls, 0.500 for roots; n: 449 for hypocotyls, 449 for roots; b: 27.95 for hypocotyls, 13.90 for roots; standard error: 1.14 for hypocotyls, 1.13 for roots; a: 70.79 for hypocotyls, 83.38 for roots; standard error: 1.45 for hypocotyls, 1.44 for roots. * marks mean angle of deviation for the given gravitational force.

P306(6/86) Aliyev AA, Mekhti-zade ER, Mashinskiy AL, Alekperov UK.

Modification of the cytogenetic and physiological effects of space flight factors by biologically active compounds.

Zhurnal Obshchey Biologii.

XLVII(2): 246-251; 1986.

[27 references; 5 in English]

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All-Union Scientific Research Institute of Biotechnology, Moscow.

Botany, Germination Rate, Mitotic Index, Growth Rate; Genetics, Chromosome Aberration

Welsh Onion, Seeds

Space Flight Factors, Salyut-7; Biologically Active Compounds,

Alpha-tocopherol, Auxin, Kinetin

Abstract: Seeds of Welsh onion (*Allium fistulosum*) plants were flown for 82 and 522 days on the "Salyut-7", while control seeds were maintained under normal conditions on the ground for like periods. The following measurements were recorded: germination rate, mitotic index and frequency of chromosome aberrations in the cells of the apical meristem of the root, and rate of growth and height of the stem on day 10 after the seeds were sown. To investigate the modifying effects of biologically active vitamin and hormonal compounds, subgroups of the control and experimental seeds were grown in solutions of alpha-tocopherol ($1 \cdot 10^{-4}$ and $1 \cdot 10^{-2}$ ug/ml), auxin ($1 \cdot 10^{-1}$ ug/ml) and kinetin ($1 \cdot 10^{-1}$ ug/ml). For the control seeds, storage for 522 days (but not 82 days) led to a significant increase in chromosome aberrations over baseline level, a predictable result of the aging process. Growing the seeds in auxin and alpha-tocopherol led to significant decreases in mutation rate after 82 days of storage, while addition of all three compounds reduced mutation rate after 522 days of storage. The seeds kept 82 days in space showed significantly increased rates of mutation over seeds stored a similar period on the ground. Space flight factors led to a significant increase in mutation rate after 522 days of exposure, but this increase was rather small compared to that attributable to natural aging over this period. Processing with alpha-tocopherol, auxin and kinetin all decreased the mutation rate of seeds flown in space to their baseline level. The authors interpret these results as demonstrating that the anti-mutational effects of the vitamins and hormones tested is independent of space flight factors.

Use of alpha-tocopherol in both concentrations stimulated an increase in the germination rate of groups of seeds stored for 82 days on the ground. An 82-day exposure to space decreased germination rate, while use of alpha-tocopherol subsequent to flight restored this parameter virtually to baseline level. This vitamin E derivative depressed mitosis of control seeds stored 82 days, indicating inhibition of growth processes in the root system, while increases in stem length demonstrated facilitation of growth of the above ground portions of the plant. Addition of auxin to 82-day control plants facilitated mitosis, but had no effect on stem growth. Space flight factors (82-day exposure) reduced mitosis to less than a third of control level and depressed stem growth. Auxin completely reversed these inhibitory effects and even appeared to stimulate stem growth. Addition of alpha-tocopherol to 82-day flight seeds increased meristem mitosis (although, not to control level), but did not affect stem length. Storage of seeds for 522 days depressed

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germination rate, combination of long-term storage and space flight factors depressed this rate even further. Addition of kinetin subsequent to storage (either on the ground or in space) restored germination rate, although not to baseline level. Kinetin fully reversed the negative effects of both long-term storage conditions on mitosis, and actually increased root growth. Alpha-tocopherol increased mitosis of seeds stored for 522 days on the ground to control level and had a positive influence on 522-day flight seeds, but did not fully restore mitosis.

The authors conclude that the results of the experiments suggest that vitamin E compensates for the adverse effects of space flight factors and the natural aging process on plant growth, while phytohormones trigger the self-regulation of plants' physiological functions and increase their nonspecific resistance to adverse factors of various kinds.

Tables and Figures: Table 1: Effect of alpha-tocopherol, auxin and kinetin on the frequency of chromosome aberrations of control seeds after 82- and 522-day storage in a laboratory and seeds exposed to space flights of the same durations

Condi- tion No.	Condition	No. of Anaphyses	% Altered Anaphyses	t_d^*
1	Control (start of experiment)	1786	5.71	--
2	Control (82 days)	2141	6.96	1.61
3	Control (522 days)	880	11.36	4.71
4	Control (82 days): α -tocopherol ($1 \cdot 10^{-4}$ ug/ml)	821	4.00	3.40
5	Control (82 days): α - tocopherol ($1 \cdot 10^{-2}$ ug/ml)	846	3.07	4.86
6	Control (82 days): auxin ($1 \cdot 10^{-1}$ ug/ml)	730	3.42	4.07
7	Control (522 days): α -tocopherol ($1 \cdot 10^{-2}$ ug/ml)	903	5.65	4.34
8	Control (522 days): kinetin ($1 \cdot 10^{-1}$ ug/ml)	855	6.20	3.82
9	Space Flight (82 days)	1985	9.72	3.20
10	Space Flight (522 days)	1327	14.32	2.06
11	Space Flight (82 days)+ α - tocopherol ($1 \cdot 10^{-4}$ ug/ml)	818	5.13	3.92
12	Space Flight (82 days) + α - tocopherol ($1 \cdot 10^{-2}$ ug/ml)	812	3.57	5.64
13	Space Flight (82 days)+ auxin ($1 \cdot 10^{-1}$ ug/ml)	637	5.34	3.94
14	Space Flight (522 days)+ α - tocopherol($1 \cdot 10^{-2}$ ug/ml)	875	6.63	6.85
15	Space Flight (522 days)+ kinetin (10^{-1} ug/ml)	864	7.41	5.27

* t_d - value of t_d between conditions: 1:2, 1:3; 2:4, 2:5, 2:6, 2:9; 3:7, 3:8, 3:10; 9:11, 9:12, 9:13; 10:14, 10:15.

BOTANY

Table 2: The effects of alpha-tocopherol and auxin on mitosis in root meristem and on stem growth of Welsh onion plants grown from seed exposed to space flight factors for 82 days

Condi- tion No.	Condition	Dividing Cells, %	t_d^*	Stem Ht, mm	t_d^{**}
1	Control (82 days)	13.44	--	47.50	--
2	Control (82 days): α -tocopherol ($1 \cdot 10^{-4}$ ug/ml)	7.27	9.38	59.60	3.70
3	Control (82 days): α - tocopherol ($1 \cdot 10^{-2}$ ug/ml)	9.50	5.13	74.60	5.36
4	Control (82 days): auxin ($1 \cdot 10^{-1}$ ug/ml)	17.94	3.99	41.40	1.87
5	Space flight (82 days)	3.93	16.04	30.00	4.90
6	Space flight (82 days)+ α - tocopherol ($1 \cdot 10^{-4}$ ug/ml)	8.95	7.09	34.80	1.18
7	Space flight (82 days) + α - tocopherol ($1 \cdot 10^{-2}$ ug/ml)	9.70	8.89	35.80	0.88
8	Space flight (82 days)+ auxin ($1 \cdot 10^{-1}$ ug/ml)	13.30	11.18	58.83	4.97

*,** - t_d of the differences between the following conditions:
1:2, 1:3, 1:4, 1:5; 5:6, 5:7, 5:8.

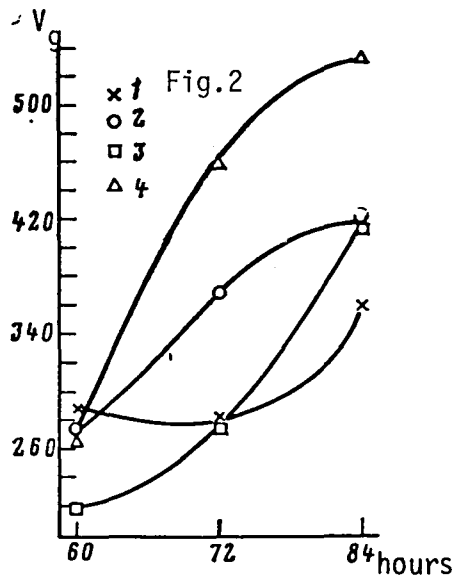
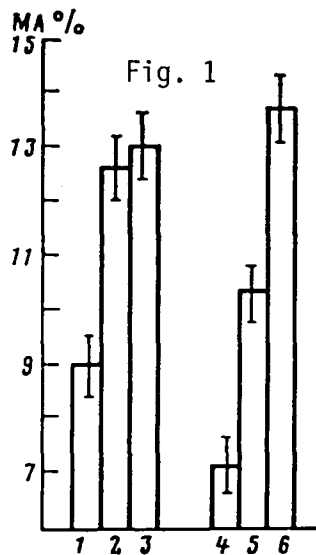


Figure 1: Effects of alpha-tocopherol and kinetin on mitosis in root meristem of the Welsh onion after seeds were stored for 522 days on the ground or in space. 1 - control (ground); 2 - control α -tocopherol ($1 \cdot 10^{-4}$ ug/ml); 3 - control - kinetin ($1 \cdot 10^{-1}$ ug/ml); 4 - space flight; 5 - space flight α - tocopherol ($1 \cdot 10^{-2}$ ug/ml); 6 - space flight + kinetin ($1 \cdot 10^{-1}$ ug/ml); MA - mitotic activity of the cells of the root meristem.

Figure 2: Effects of kinetin on rate of growth of roots of the Welsh onion after 522-day storage of seeds; 1 - control (stored on ground); 2 - control: kinetin ($1 \cdot 10^{-1}$ ug/ml); 3 - space flight; 4- space flight + kinetin ($1 \cdot 10^{-1}$ ug/ml). V_g - rate of growth (μ moles/hr).

CARDIOVASCULAR AND RESPIRATORY SYSTEMS

(See also: Neurophysiology: M85)

PAPERS:

P287(6/86)* Doroshev VG.

Venous pressure in the jugular veins and the effectiveness of return of blood to the right heart during a 120-day period of hyperkinesia with head-down tilt.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 38-41; 1986.

[7 references; 1 in English]

Cardiovascular and Respiratory System, Venous Pressure, Jugular, Blood Return, Right Heart

Humans, Males

Hypokinesia, Head-down Tilt, Long-term

Abstract: Subjects in this experiment, 14 healthy males aged 25-41, underwent a 120-day period of bedrest with head-down tilt of -40° . All received the same diet and amount of water. Subjects were divided into 4 groups; Group 1 was the control; Group 2 participated in a special exercise program designed to develop strength and endurance, supplemented by passive extension of certain muscle groups; Group 3 received a combination of drugs designed to prevent bone demineralization and to correct lipid metabolism; Group 4 combined the treatments given to Groups 2 and 3. Venous pressure and coefficient of effective return of blood to the right heart were measured. Venous pressure was measured in the morning, 1 to 1.5 hours after breakfast before the beginning of treatment and on days 2, 5, 49, 70, 90 and 119 of the head-down hypokinesia period. On the basis of baseline data, subjects were divided into those with initial low venous pressure and those with normal values of venous pressure. Response of venous pressure to the hypokinesia treatment showed marked differences across individuals. Three basic patterns were noted: venous pressure dropped below baseline levels; venous pressure dropped but periodically returned to baseline level, followed by progressive increases; venous pressure increased substantially, but returned periodically to baseline levels. Actual venous pressure in the jugular did not always coincide with subjective sensations of blood rushing to the head. In the baseline period, the effective blood return coefficient was equal to 0 in 3 subjects, less than 1 in 5 and greater than 1 in 6. On days 2 and 5 of the treatment, this parameter was 0 in 9 subjects, dropped relative to baseline in 6 and increased in 11. In all but one of the experimental subjects, the effective blood return index had a tendency to increase over the treatment period. Evaluation of this parameter indicated that exercise alone did not improve the return of blood to the right heart, while drugs had a moderate effect, and the combination of treatments substantially improved this parameter. On the basis of this data, prediction of levels of orthostatic tolerance after completion of the 120-day period were made, and were confirmed in 12 out of 14 cases. The author concludes that if the coefficient of blood return to the heart is 0 or equal to baseline values at the end of a period of hypokinesia with head-down tilt, then orthostatic tolerance will be impaired. The author recommends further study of the dynamics of venous pressure and

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blood return to the heart for evaluating countermeasures to head-down tilt and predicting orthostatic tolerance after exposure to this factor.

Table Titles: Table 1: Changes over time in venous pressure (in mm Hg) in the jugular veins during hypokinesia with head-down tilt

Table 2: Changes in a coefficient of return of blood to the heart in a static loading test during hypokinesia with head down tilt

CARDIOVASCULAR AND RESPIRATORY SYSTEMS

P288(6/86)* Bystrov VV, Zhernavkov AF, Savilov AA.

Human cardiac function during the first hours and days of hypokinesia with head-down tilt (on the basis of echocardiographic data).

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 42-46; 1986.

[25 references; 11 in English]

Cardiovascular and Respiratory Systems, Echocardiography

Humans, Males

Hypokinesia, Head-down Tilt

Abstract: Subjects in this experiment were 6 healthy males aged 19-24. Subjects underwent a 7-day period of hypokinesia with head-down tilt of -10° . Ultrasound cardiography was performed 6 times on the first day while subjects were at rest, twice on the second day and once each on days 3-7. The echocardiograms were used to determine heart rate, end diastolic and systolic dimensions and volume of the left ventricle, left ventricle ejection interval, diameter of the left auricle, lumen of the root of the aorta, thickness and excursion of the wall of the left ventricle and interventricular septum in systolis and diastolis, excursion of the mitral valve, stroke and minute volume, ejection fraction, shortening of the back to front dimension of the left ventricle, and rate of circulatory shortening of fibers in the myocardia. During the entire period of the experiment all subjects felt well and exhibited no clinically significant symptoms of disruption of cardiac function. Heart rate was somewhat below baseline level, reaching a minimum (12% reduction) on day 2; on days 6 and 7 it showed some tendency to return to normal. No significant changes were noted in the thickness or excursion of the wall of the left ventricle or interventricular septum, nor in the mitral valve. The diameter of the aorta and ejection interval also remained constant. However, during the first 2 hours of hypokinesia, end diastolic and stroke volume increased, by 6 and 10% respectively. The values of these parameters dropped to somewhat below baseline from hour 3 to the end of the day 1. During day 3 they increased again significantly, as did end systolic volume (by 8%). During days 4-7 these parameters gradually returned to and remained at baseline level. Minute volume showed the same pattern as these three indicators, however, it remained at baseline or somewhat below, because of the decrease in heart rate. The diameter of the left auricle decreased slightly throughout the period, but these changes were not statistically significant. No changes were noted in ejection and shortening fractions, nor in rate of shortening of myocardial fibers, suggesting to the authors that no disruption of myocardial contractility occurred, in spite of the changes in the phase structure of intracardiac circulation and cardiac pumping function. The authors recommend that differences in cardiac response to weightlessness over the first week of exposure be considered when prophylactic measures are selected. However, optimal selection requires performance of an analogous cardiac ultrasound study under actual space flight conditions.

Table Title: Changes in echocardiographic parameters during 7-day exposure to hypokinesia with head-down tilt

P292(6/86)* Demin AN, Belkaniya GS, Dartsmeliya BA.

Typology of monkeys in horizontal and upright positions based on parameters of central hemodynamics.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 60-64; 1986.

[16 references; none in English]

Cardiovascular and Respiratory Systems, Central Hemodynamics, Impedance
Plethysmography

Primates, Rhesus Monkeys, Typology

Horizontal and Upright Positions

Abstract: Seventy-four male rhesus monkeys, 1 through 8 years old, served as subjects in this experiment. Central hemodynamic parameters were measured using tetrapolar impedance plethysmography while the animals were strapped to a tilt table. The following indices (normalized for body weight) were computed: stroke index, cardiac index, specific peripheral vascular resistance. In addition, systolic and diastolic blood pressure were measured and averaged. Heart rate and an indicator of myocardial contractility were also recorded. These parameters were measured while the animal was in horizontal position and in minutes 1-5, 10, 15 and 20 while he was upright. Reactions of hemodynamic parameters to the upright position fell into two phases. During the first phase, occurring in minutes 1-10, the hydrostatic factor was dominant and parameters reflected the organism's adaptive reactions to compensate for fluid shifts. Parameter values in minutes 10-20 reflected stabilized regulation of the cardiovascular system. For the sample as a whole, mean blood pressure (defined as $BP_{dias} + 0.42(BP_{sys} - BP_{dias})$) was below (by ca.

5%) horizontal baseline for the entire period recorded. However, in individual monkeys, blood pressure in upright position ranged from a 38% decrease to a 16% increase over baseline value. For the group as a whole, heart rate increased by ca. 14% and 13% in the two phases; stroke volume decreased by 23% and 37%; cardiac index decreased by 11% and 26%, while specific resistance changed by -10% and +4%. When monkeys were divided into 2 groups on the basis of whether blood pressure increased or decreased, there were no significant differences between them in reactions of these other parameters, with the exception of heart rate, which increased more for monkeys whose blood pressure increased. This suggests that direction of changes in blood pressure in response to an upright position is not a useful basis for classifying overall reaction types. Changes in cardiac index with respect to horizontal baseline were selected as a better classifier. Monkeys whose index decreased were called hypokinetic circulation types and were divided into two groups on the basis of the magnitude of this decrease: CI of Group II (40% of the subjects) ranged between 84% and 68% of horizontal baseline in the upright position; while CI values for Group I (15% of the subjects) were below 68% of baseline. Group III (33% of total) was called eukinetic and showed little change in CI in the upright position ($116\% > CI > 84\%$); while in Group IV (12% of the total), the hyperkinetic group, CI increased to more than 116% of horizontal baseline. In the hypokinetic groups, the greatest decrease in cardiac ejection was paralleled by the greatest increase in peripheral vascular resistance, and it is thus concluded that, in these individuals, pressure is maintained in the upright position through peripheral vasoconstriction. In hyperkinetic individuals pressure

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appeared to be maintained by increases in myocardial contractility (amplitude of differential phlethysmogram increased by 75%) and a relatively large increase in heart rate (27%), while resistance decreased. In eukinetic monkeys, changes in vascular resistance and myocardial contractility were intermediate in magnitude. There appears to be a kind of reciprocal relationship of the values of cardiac parameters in horizontal and upright positions between the groups. Thus, hypokinetic monkeys with the largest decrease in cardiac ejection and greatest increase in peripheral resistance in upright position, have the highest cardiac index and lowest peripheral resistance in horizontal position. The authors conclude that this study suggests that in evaluating the reaction of the cardiovascular system one should focus, not on overall changes in parameters, but on types of reaction patterns.

Table and Figure Captions: Table 1: Parameters of central hemodynamics for monkeys of the four hemodynamic types in orthostatic position

Index	Total Sample	Type of Hemodynamics in Upright Position			
		I	II	III	IV
BP _{mean}					
A	115	116	110	120	117
B	96	97	96	97	96
C	94	93	94	92	96
Stroke Index					
A	2.1	2.75	2.41	1.33	1.34
B	77	59	75	94	109
C	63	48	62	86	109
Cardiac Index					
A	427	631	526	285	234
B	89	64	88	107	136
C	74	51	69	98	136
Specific Peripheral Resistance					
A	39,449	16,965	27,520	45,210	89,559
B	90	157	116	95	74
C	104	190	138	95	74
Heart rate					
A	210	235	211	211	183
B	114	108	116	114	127
C	113	107	113	114	127
Amplitude of Differential Plethysmogram					
A	2.97	4.16	3.29	2.5	1.76
B	139	120	136	155	175
C	144	122	141	163	175

Key: A - absolute value of the index in horizontal position; B and C - mean values of the index in minutes 1-5 and 10-20 in upright position (in % of baseline with horizontal position value set at 100%)

Figure 1: Changes over time in the major central hemodynamic parameters in monkey in upright position

Figure 2: Phase relationships among major hemodynamic states (types I-IV) in monkeys in upright position

P308(6/86)* At'kov OYu.

The state of cosmonauts' cardiovascular systems during long-term orbital flights.

Byulleten' Vsesoyuznogo Kardiologicheskogo Nauchnogo Tsentra AMN SSSR.
VIII(2): 97-100; 1985.

[4 references; 3 in English]

All-Union Cardiological Scientific Center.

Cardiovascular and Respiratory Systems, Echocardiography, Hemodynamics
Humans, Cosmonauts
Space Flight, "Salyut-7", LBNP, Physical Exercise

Abstract: Echocardiographic studies were performed on 15 cosmonauts in the 7 primary crews performing 75-, 96-, 140-, 175-, and 185- day flights on "Salyut-6" and the 2 crews of "Salyut-7" who completed 7- and 8-month orbital flights. Echocardiography performed at rest during the first day postflight showed some decrease in stroke ejection caused by a decrease in the volume of the left ventricle. There was no concomitant change in contractility. An increase in the diameter of the left auricle was observed in half of the cases. By the end of the first week postflight the echocardiographical parameters approached their normal values; normalization was complete for all parameters by day 25 postflight. Frequent echocardiographic studies were made during the flight of the third primary crew on the "Salyut-7"- "Soyuz-T" complex, at rest, during ergometric exercise and LBNP (lower body negative pressure). Each cosmonaut exhibited an individual pattern in these measurements. Parameters of contractility were either at or somewhat above preflight levels. Two of the crewmembers showed some decrease in end diastolic volume and stroke ejection. The third cosmonaut showed increased values for these parameters, accompanied by brachycardia. One of the three cosmonauts exhibited decreased size of the left auricle. On day 1 postflight, central hemodynamic parameters were still similar to their flight values. By day 9 there was a tendency for all parameters to approach normal levels, which had occurred by the end of the fourth week postflight. Central hemodynamic parameters during tests with LBNP and exercise on a bicycle ergometer were performed in two crewmembers. The negative pressure schedule involved 5 minutes each of -15, -25, -35, and -45 mm Hg. An echocardiogram of the left portion of the heart was performed before the test and at minutes 1 and 5. Preflight LBNP was associated with decrease in the size of the left auricle, end diastolic pressure and stroke ejection in both subjects. Ejection fraction remained constant. Minute volume dropped at the lowest pressure levels. During the flight, these parameters at rest were below their preflight levels, and during LBNP in flight these parameters were close to their baseline values. The ratio between filling of the left ventricle and stroke ejection remained constant under all conditions and no signs of change in contractility were detected. Responses to LBNP in the early readaptation period were similar to those during flight. During preflight bicycle ergometric tests (PWC-170), both cosmonauts showed increased end diastolic volume and decreased end systolic volume of the cavity of the left ventricle. Stroke ejection increased by 27-45% of baseline, and minute volume grew due to increase in heart rate and stroke ejection. During flight, both astronauts showed the same pattern of reaction. At rest, the volume of the left ventricle was decreased in comparison with preflight values, while changes in stroke ejection were insignificant. Minute

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volume was unchanged. During exertion, stroke ejection was lower than for the corresponding loading preflight. Increased minute volume was due only to heart rate increase and was lower than preflight values.

Dr. At'kov's conclusions follow.

1. Parameters derived from echocardiographic studies performed on cosmonauts at rest at various points during an orbital flight reveal no substantial differences from parameters of the pumping and contractile functions of the heart measured preflight. This permits us to hypothesize that at rest the mechanisms of cardiovascular regulation support a rather stable level of intracardiac hemodynamics during long-term (8 month) space flights.

2. Changes in hemodynamics in response to a provocative test with LBNP performed during space flight, involving a pronounced drop in stroke ejection and increase in heart rate (which led to a greater increase in minute volume), may be considered to be compensatory reactions directed toward support of cerebral circulation during decrease in peripheral vessel tonus. Ultrasound data allow us to conclude that the moderate decrease in orthostatic tolerance occurring after long-term space flight is not a result of deterioration of the functional state of the myocardium.

3. The lower values of stroke ejection during exertion and the compensatory increase in heart rate (for support of adequate minute volume) demonstrates a reorganization of hemodynamics during flight, and not an increase in the relative difficulty of physical exertion or disorder of myocardial contractility. The most probable reason for the hemodynamic changes observed is the decrease in the volume of circulating blood, leading to some decrease in venous return of blood.

Table 1: Changes in major central hemodynamic parameters on the day 1 postflight (in % of preflight value)

	Crew															Mean
	1		2		3		4		5		6		7			
Crewmember	1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	
Parameter																
Term. Syst. Volume	-20	+9	-20	-47	-51	-40	-37	-14	-21	-10	0	-11	-28	-36	-20	-23
Term. Dias. Volume	-17	-4	-9	-42	-35	-22	-32	-16	-14	-6	-10	-12	-12	-21	-9	-17
Stroke Ejection	-15	-10	-1	-39	-13	-6	-29	-17	-9	+3	-15	-13	-2	-13	-3	-13
Ejection Fraction	+3	-6	+9	+6	+34	+21	+5	0	+7	+2	-4	-2	+11	+11	+6	+7
Rate of muscle fiber contraction	0	-8	+9	+20	+30	+27	+1	-7	+13	+13	+9	+8	+6	+13	+6	+18
Left auricle diameter	-3	-7	+9	+20	0	+4	+23	+14	-6	0	-15	0	+3	-7	-7	+2

In crew 7, studies were performed on day 2.

CARDIOVASCULAR AND RESPIRATORY SYSTEMS

MONOGRAPH:

M81(6/86) Ozolin' PP.

Adaptatsiya sosudistoy sistemy k sportivnym nagruzkam

[Adaptation of the vascular system to athletic training [literally, athletic loading]

Riga: Zinatne; 1984.

[134 pages; 44 figures; 16 tables; 307 references; 129 in English]

Latvian Ministry of Public Health; Latvian Scientific Research Institute of Experimental and Clinical Medicine

Keywords: Cardiovascular and Respiratory Systems, Vascular Adaptation; Physical Exercise, Athletes; Musculoskeletal System

Annotation: This book examines the adaptation of the vascular system to systematic athletic training. The focus is on the mechanisms governing regulation of blood supply to the limbs. Approximately 1500 athletes and untrained individuals were studied using modern methods (venous occlusion, plethysmography, photosphygmography, rheocardiography, etc.). These studies identified properties of adaptation in various components of the vascular systems (major arteries and resistance vessels), of various organs (the muscles and skin) and also changes in vascular reactions as a function of the age and sex of athletes, and the nature of athletic training they underwent. The importance of adequate blood supply to the athletes' limbs to attainment of high levels of athletic performance is examined.

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DEVELOPMENTAL BIOLOGY

PAPER:

P295(6/86)* Mishchenko VF, Shafirkin AV.

Viability of quail embryos and nestlings from eggs exposed to gamma-radiation and vibration and stored for varying intervals.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 72-77; 1986.

[15 references; 2 in English]

Developmental Biology, Viability; Life Support Systems, CELSS

Quail, Eggs

Longterm Storage, Vibration; Radiobiology, Ionizing Radiation

Abstract: Quails have been proposed as a possible heterotrophic link in closed ecological life support systems. The development of technology for using these birds for continuous supply of eggs and meat requires study of the effects of space flight factors on their developmental viability. The factors studied in this research were vibration, ionizing radiation and long-term storage of eggs before incubation. Each of the three experiments used both on-site control and transport control groups. The experiment on ionizing radiation used 920 eggs, stored no longer than 10 days before incubation. The experimental group of eggs were exposed to gamma-radiation with a ^{137}Cs source at a dose rate of 10 cGy/min in doses of from 1 to 1200 cGy. After irradiation, eggs were immediately returned to the laboratory, and placed in an incubator for further observation. The proportions of developing eggs, and embryos dying at various stages were recorded, as was the viability of the chicks hatched over a 10-day period. In the study of length of storage, six groups were randomly selected for incubation at five day intervals. The eggs were stored in a refrigerator at $10 \pm 1^\circ\text{C}$. Eggs and resulting hatchlings were observed as described above. The third experiment investigated the combined effects of storage and vibration or gamma-irradiation. For this study, 695 eggs which had been stored for 3 days were transported to the study site on a 3-hour aircraft flight. In the vibration condition, the eggs were placed in a padded container on a vibration table, and vibrated and accelerated according to a complicated schedule, for periods of 10-minutes. Eggs were positioned either with their long axis parallel or perpendicular to the plane of the table. After vibration the eggs were incubated and observed. In the condition combining storage and radiation, two groups of eggs stored for 30 days were irradiated at doses of 300 cGy and 500 cGy. Irradiation at a dose of 1-300 cGy had no detrimental effects on the viability of quail embryos or eggs, indeed at very low doses viability increased somewhat. Doses of 500-1000 cGy led to significant decreases (by a factor of 1.6-6) in viability of both embryos and chicks. These higher doses may be analogous to those expected during longer interplanetary flights. Storage of eggs up to 15 days with stable temperature and humidity did not impair viability. Storage for more than 20 days led to a decrease in percent of embryos developing by a factor of 2.5 and a five fold decrease in number of chicks hatching. Adding the factor of vibration further decreased viability of eggs stored for 30 days when the eggs were oriented parallel to the vibration table or perpendicular to it with the small end pointed down, but when the small end of the egg

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pointed up, viability increased somewhat over nonvibrated eggs with the same length of storage. Addition of 300 cGy of gamma-radiation had no further deleterious effects on the viability of eggs stored for 30 days; however, irradiation, of 500 cGy did further decrease embryo and chick viability.

Table 1: Proportion of developing embryos and viable chicks after exposure of eggs to gamma-irradiation in various doses

Table 2: Proportion of developing embryos and viable chicks after storage of eggs for varying intervals before incubation

Table 3: Proportion of developing embryos and viable chicks after exposure to gamma-irradiation or vibration and 30-day storage prior to incubation

Figure 1: Changes in viability of embryos or chicks as a function of dose of gamma radiation

Figure 2: Change in viability of embryos and chicks after long-term storage, irradiation, long-term storage combined with vibration, or long-term storage combined with irradiation

ENDOCRINOLOGY: See Musculoskeletal System: P298; Neurophysiology: M85;
Radiobiology: P283)

ENZYMOLGY

PAPERS:

P300(6/86)* Medkova IL, Nikolayeva NM, Smirnov KV, Surinov BP.

A method for measuring the activity of phospholipases in duodenal contents.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 92-94; 1986.

[10 references; 3 in English]

Abstract: This paper proposes a spectrophotometric method for measuring the enzymatic activity of A-2 phospholipases in duodenal contents. The only substrate to provide satisfactory results was natural egg lecithin after emulsification of the yolk in the presence of Ca^{2+} ions and deoxycholate. A dilution factor of 20 for the duodenal contents was found to be best. Zymogen is transformed into an active enzyme by the introduction of trypsin into the sample. Incubation occurs at 37° ; 1.5 hours was found to be the optimum incubation period, sufficient for induction of enzymatic activity but short enough to minimize separation of the fatty acids from the lecithin. When a substrate of egg lecithin is used, the amount of fatty acid released is determined by titration or potentiometry. The authors' method involved measuring fatty acids in the form of copper salts, stained with a chromogenic complexing agent and extracted with an organic solution. The chromogenic complexing agent selected was sodium diethylditriocarbamate, used for the analysis of pancreatic lipase and monoglyceride lipase. In this way the exact quantity of fatty acids released by the action of the enzyme can be measured using a spectrophotometer. This analysis offers the advantage of using a single technique for the analysis of three different enzymes -- pancreatic lipase, monoglycerides and phospholipases.

P290(6/86)* Popova IA.

Activity of blood serum enzymes in healthy men during simulated weightlessness.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 54-57; 1986.

[9 references; 5 in English]

Enzymology, Alkaline Phosphatase, Cholinesterase, Leucine Aminopeptase,
Glutamyltransferase, Glutamate dehydrogenase
Humans
Simulated Weightlessness, Hypokinesia, Head-down Tilt, Horizontal

Abstract: Subjects in this study were healthy male volunteers, aged 31-40. Some (n's not given) underwent hypokinesia with or without head-down tilt (-6° and -15°) for a period of from 2 to 8 days; while others underwent "dry" immersion up to the neck in a sitting position for the same periods. Venous blood was collected from subjects 2-3 times before simulated weightlessness, 3-5 times during the treatment, and 2-3 times in the recovery period. Activity of enzymes in the blood was determined using enzymospectrophotometry or colorimetric methods. The enzymes studied were: alkaline phosphatase (AP), cholinesterase (CE), leucine aminopeptidase (LA), glutamyltransferase (GT), and glutamate dehydrogenase (GD). Horizontal hypokinesia (bed rest) led to no large changes in enzyme activity, although there was a tendency for most enzymes to decrease (statistically significant for LA on day 2, and for CE and GD on days 2 and 8 of recovery, respectively). When -6° head-down tilt was added to this treatment, the tendency for enzyme activity to decrease was more marked. Significant decreases were found for LA on days 6 and 8 of the treatment and day 3 of recovery, and for GD throughout the treatment and recovery period. Increasing tilt to -15° , however, did not lead to significant changes in enzyme activity, although there was a slight tendency toward increase. Nor did the immersion procedure lead to any major changes in enzyme activity, but again there was a tendency toward increase. The author concludes that restriction of physical activity in all the weightlessness simulations studied is associated with decreases in enzyme activity, while the additional factor of fluid shifts occurring in response to head-down tilt and immersion are associated with increases in enzyme activity in the blood. In space flight, where effects of fluid shifts are not countered by hypodynamia, activity could be expected to increase to a greater extent, which has been found to be the case.

Table Titles: Table 1: Activity of enzymes in human blood serum during bedrest in a horizontal position

Table 2: Activity of enzymes in human blood serum during hypokinesia with head-down tilt (-6°)

Table 3: Activity of enzymes in human blood serum during hypokinesia with head-down tilt (-15°)

Table 4: Activity of enzymes in human blood serum during immersion up to the neck in a sitting position

EXO BIOLOGY

PAPER:

P280(6/86) Kuzicheva YeA, Tsupkina NV.

Nonbiological synthesis of uridine nucleotides under space flight conditions in the "Salyut-7" orbital station.

Zhurnal Evolutsionnoy Biokhimii i Fiziologii

XXII(1): 17-23; 1986.

[15 references; 4 in English]

Institute of Cytology, USSR Academy of Sciences, Leningrad

Exobiology, Origin of Life

Uridine Nucleotides, Nonbiological Synthesis

Space Flight, "Salyut-7"; Radiobiology, Ultraviolet Radiation

Abstract: Both flight and ground-based laboratory experiments are described in this paper. In the ground-based laboratory experiments induction of nucleotide synthesis was attempted using a combination of ultraviolet radiation with wavelength of 254 nm and high temperature ($50 \pm 2^\circ\text{C}$). In the photochemical synthesis of nucleotides, a solution containing (M): 0.4 sodium hydrophosphate, 0.4 urea, 0.4 ammonium phosphate and 0.4 uridine in the ratio of 1:10:10:10 in volume was dried over alkali and the resulting film irradiated with ultraviolet light at a dose rate of $18 \text{ J/cm}^2 \cdot \text{hr}^{-1}$. In the high temperature condition, a waterless mixture of sodium hydrophosphate, urea, ammonium chloride and uridine, in molar ratio of 1:10:10:1 was heated for 1 to 8 months. The ground-based experiments used a nitrogen atmosphere. The flight experiments utilized a specially developed holder, the "Meduza" which housed ampoules containing the probes being studied. In the first series of experiments the ampoules were secured on the outer surface of the device so that the mixtures were exposed to the combined effects of sharp temperature differentials and ultraviolet light. In the second condition, the ampoules were shielded by a metal screen and thus exposed only to temperature changes. The ampoules contained a mixture of sodium hydrophosphate, urea, ammonium chloride and uridine in molecular ratio of 1:10:10:10. Both sets of ampoules were flown in space for 16 months. Resulting compounds were subjected to ion-exchange, thin layer, paper chromatography, gel-filtration techniques, as well as acid and enzyme hydrolysis to identify and measure synthesized nucleotides.

In the ground-based conditions, ultra violet irradiation led to the synthesis of a single new compound with an elution volume identical to that of uridine-2',3'-cyclophosphate (cUMP). This compound was homogeneous, had an R_f value identical to that of cUMP and differed from it only minimally in molecular weight. Acid hydrolysis revealed that this substance was a derivative of uracil. The new compound contained phosphorus in 1:1 ratio with nucleoside, but the absorption spectrum differed from that of natural nucleotide. The maximum amount of this substance (0.12%) was synthesized under a radiation dosage of 18 J/cm^2 . Under the thermal stimulation ground condition, two new fractions were identified with elution volumes equal to cUMP and uridine-5'-monophosphate (5'UMP). The molecular weight, R_f value and absorption spectra of these products coincided with those of the natural nucleotide. The second

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compound was determined to be a mixture of 2'(3')cUMP (36%) and 5'UMP (64%). The maximum amount of the two new compounds was equal to 3% and 4% and occurred after 8 months of heating. The maximum decomposition of uridine was 12%.

Both the shielded and the non-shielded space conditions gave rise to a single new fraction each, called F_4 in the non-shielded and F_5 in the shielded condition. The molecular weights of both these compounds coincided with that of uridine monophosphate and their spectra were similar to those characteristic of nucleotides. For both, the value of R_f was identical to natural 5'UMP. In both conditions the yield of uridine monophosphate was 0.15%. The ratio of 2'(3')- and 5'-monophosphates in the uridine monophosphate mixture was 30:70 in the first (non-shielded) condition and 40:60 in the second condition. Decomposition of the initial uridine in the test mixture was 30% in the first condition and 40% in the second. The authors conclude that since thermal stimulation on the ground and both flight conditions gave rise to the synthesis of identical natural mononucleotides, thermal energy is the key factor in inducing synthesis. They argue that such prebiological reactions could have taken place on the lithosphere of Earth or a similar planet or on particles of interstellar dust and that therefore study of nonbiological synthesis of nucleotides is important to the understanding of the origin of life and to the search for extraterrestrial life.

Table and Figure Titles: Table 1: Characteristics of products obtained through the phosphorylation of uridine during exposure to various sources of energy, and of control preparations

Energy source	Product	Molec. Weight	R_f , (Sephadex)	R_f , Paper I ¹	R_f , Paper II ²	Maximum Yield (%)
Ground:						
UV radiation	F_1	350	0.67	--	--	0.12
Temperature 50°	F_2	380	--	0.57	0.04	4.0
	F_3	370	--	0.47	0.02	3.0
Flight:						
Non-shielded ³	F_4	380	--	0.49	0.02	0.15
Shielded ⁴	F_5	380	--	0.48	0.02	0.15
Control:						
cUMP ⁵		364	0.67	0.57	0.04	--
5'UMP ⁶		364	0.41	0.49	0.02	--

¹ Solvent I (ethanol, ammonium acetate, pH = 5)

² Solvent II (n.-butanol and acetic acid)

³ UV radiation and temperature range from -50 to 50°C

⁴ Temperature range alone

⁵ Uridine-2',3'-cyclophosphate

⁶ Uridine-5'-monophosphate

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Table 2: Optical properties of nucleotides synthesized through phosphorylation of uridine during exposure to various sources of energy and of control preparation

Energy source	Product	Absorption spectra at various pH					
		1.0		6.0		10.0	
		max	min	max	min	max	min
Ground:							
UV radiation	F ₁	265	244	262	244	--	--
Temperature 50°	F ₂	265	235	265	235	265	236
	F ₃	264	235	263	235	265	238
Flight:							
Non-shielded	F ₄	260	235	260	235	257	248
Shielded	F ₅	260	235	261	235	263	243
Control:							
cUMP		264	232	264	232	264	243
5'UMP		264	232	264	232	264	243

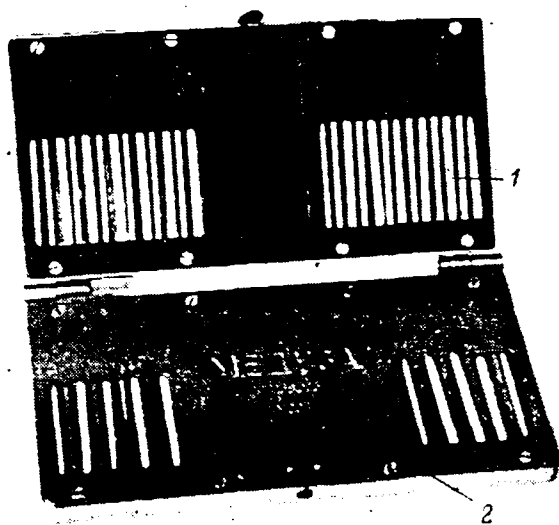


Figure 1. "Meduza" holder

- 1 - ampoules which are exposed on the outer surface of the device
 2 - metal plate covering remaining ampoules

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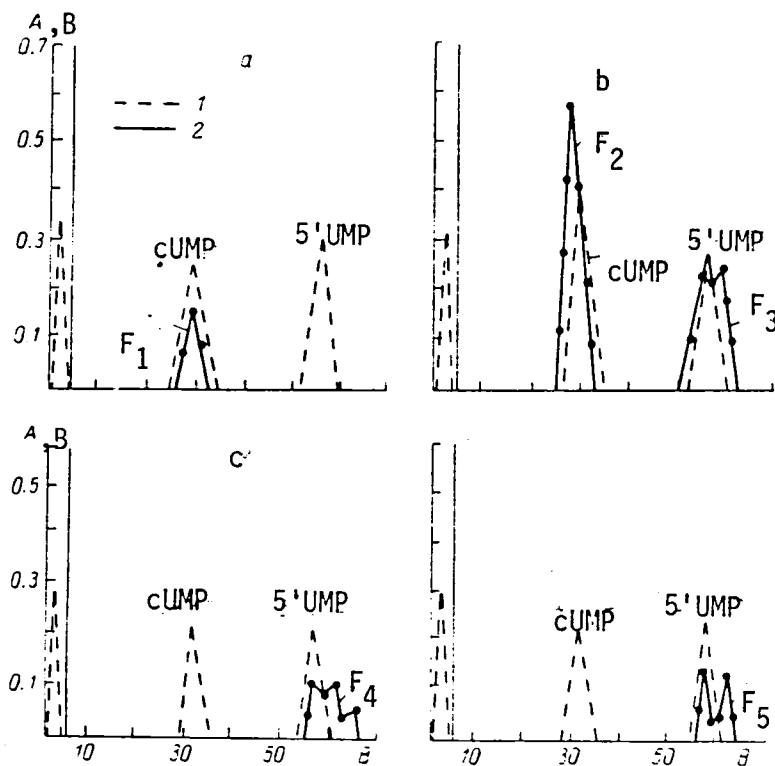


Figure 2 - Separation of products synthesized from uridine in the presence of phosphorylizing mixtures and exposure to various energy sources, to DEAE-Sephadex A-25

a-UV radiation, wavelength 254 nm, dose $15 \cdot 10^2 \text{ J/cm}^2$; b - temperature 50° , exposure duration 8 months; c - space flight factors, combined effects of UV radiation and temperature ranging from -50 to 50°C , exposure duration 16 months; d - Space flight factors, temperature ranging from -50 to 50°C , exposure duration 16 months. A - D_{260} ; B - uridine; C - fraction number. 1 - control; 2 - experiment.

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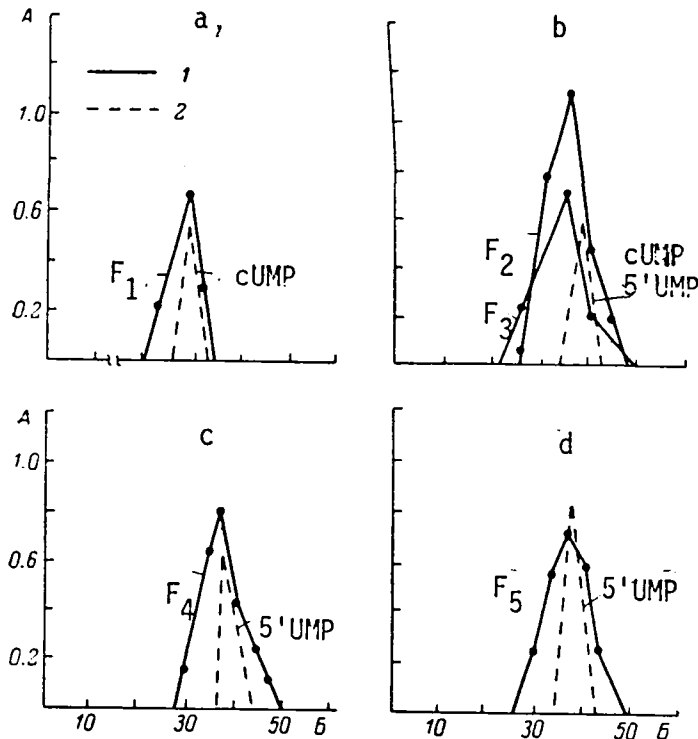


Figure 3: Purification of products synthesized from uridine in the presence of phosphorylizing mixtures during exposure to various sources of energy, to Sephadex - G-10.

a - d -- as in Figure 2. A - D_{260} , B - elution volume (ml). 1 - 2 -- as in Figure 2.

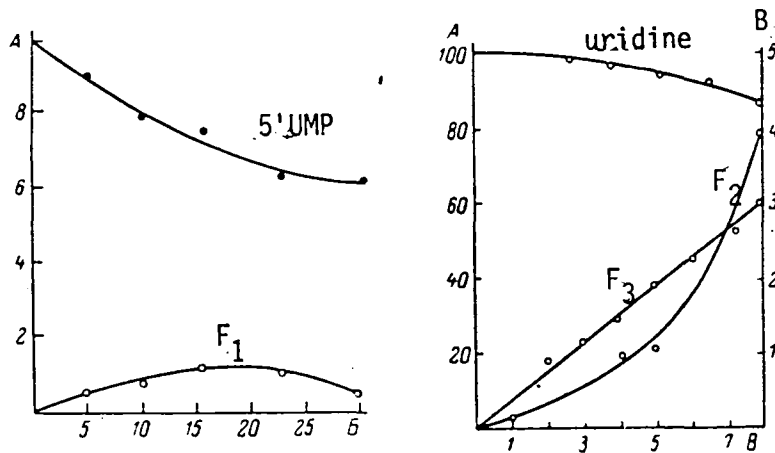


Figure 4: Yield of product F₁, synthesized through photoirradiation of uridine in a medium containing phosphates and decomposition of 5' UMP as a function of radiation dose.

A - quantity of substance (%); B - dose of UV radiation $10^2 \cdot J/cm^2$

Figure 5: Yield of products F₂ and F₃ synthesized from uridine in the presence of phosphorylizing mixtures, and decomposition of uridine as a function of duration of heating.

A - nonreacting nucleosides (%); B - synthesized nucleotides (%); C - duration of heating (months).

GENETICS: See Botany: P306

HABITABILITY AND ENVIRONMENT EFFECTS

PAPER:

P297(6/86)* Knyazev VM, Korol'kov VI, Viktorov AN, Pozharskiy GO, Petrova LN, Gorshkov VP.

Hygienic microbiological aspects of shared habitation of a hermetically sealed living space by humans and animals.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 80-82; 1986.

[10 references; 2 in English]

Habitability and Environmental Effects, Hermetically Sealed Environment
Humans, Dogs
Microbiology, Microflora

Abstract: Two humans and two animals (dogs) spent 30 days in a hermetically sealed living space 24 m^3 in size, consisting of two connecting sections. Throughout this period, the humans performed experiments on the dogs and cared for them. The amount and composition of microflora of the atmosphere, cabin surfaces, and mucous membranes of the humans and animals were determined every 3 days. Data resulting from the atmospheric measurements are given in the table below. Atmospheric microflora fluctuated periodically in both cabin sections, but there were no differences between sections in microbe levels. Levels of fungoid microflora showed more frequent periodic increases in the section occupied by the animals than in the human section. Studies of the cabin surfaces revealed pronounced accumulation of microflora similar to those found on human skin. Studies of the microflora of the upper respiratory tracts of the humans revealed a total increase by a factor of $1 \cdot 10^3 - 5 \cdot 10^3$ in overall level. A marked increase in the level of pathogenic Staphylococcus (phagotype 80) was observed in the nose of one (M) of the subjects. This strain, while not observed in the nose of the other human subject was found on his skin. Phagotype 3-A was observed in the nose of the second subject (K). Total levels of skin microflora were relatively stable throughout the period. Gram negative bacilli appeared on the skin of both humans and reached a relatively high level in subject M. Both of the pathogenic staphylococcus phagotypes identified on the humans were found on the dogs. These results suggest the desirability of providing self-contained life support systems for animals and humans sharing a spacecraft cabin.

HABITABILITY AND ENVIRONMENT EFFECTS

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Table: Microbial concentration in the atmosphere in the first (human occupation) and second (dog occupation) section (number of microorganisms in 1 m³ of air)

Parameter	Base-		Day of Experiment									
	line	3	6	9	12	15	18	21	24	27	30	
Section 1 (human habitation)												
Epidermal staphylococci	800	1060	1160	550	790	310	2860	1360	1870	1210	1440	
Pathogenic staph.	10	--	10*	--	--	10*	--	50*	--	--	--	
α-Hemolytic strep.	5	5	--	30	30	--	20	--	10	--	--	
Corynebacteria	15	10	--	--	--	30	--	--	--	60	30	
Spore-forming bacilli	90	45	20	--	20	10	--	--	10	--	--	
Gram-negative bacilli	--	5	--	10	--	--	--	220	--	--	--	
Gram-negative cocci	--	45	10	--	--	--	20	--	210	--	30	
Total level of micro-organisms	920	1170	1200	590	840	360	2900	1630	2100	1270	1500	
Section 2 (animal habitation)												
Epidermal staphylococci	640	740	840	720	2280	730	1290	1020	2120	870	1320	
Pathogenic staph.	50	--	340*	--	--	--	10*	30*	--	--	--	
α-Hemolytic strep.	5	20	10	--	--	30	--	220	10	20	--	
Corynebacteria	80	160	--	--	--	--	--	--	--	--	--	
Spore-forming bacilli	30	--	--	110	20	--	--	20	70	--	10	
Gram-negative bacilli	5	50	10	--	--	--	--	10	--	--	30	
Gram-negative cocci	--	60	--	--	--	10	--	--	--	40	40	
Total level of micro-organisms	810	1030	1200	830	2300	770	1300	1300	2200	930	1400	

* Staphylococcus phagotype 80.

HEMATOLOGY

(See also: Radiobiology: P283)

PAPER:

P291(6/86)* Lavrov VI, Goncharov IB, Davydkin AF, Ivanov AP, Romanov AN, Ivchenko VF.

[Results of] Paramecium test for toxic substances in the blood of men undergoing simulated weightlessness.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 58-59; 1986.

[12 references; none in English]

Hematology, Blood Toxicity, Paramecium Test

Humans

Weightlessness, Simulated, Hypokinesia, Head-down Tilt, Immersion

Abstract: In the "paramecium test" of blood toxicity, the length of survival of suspensions of paramecia in 0.01 ml of blood plasma of a test subject is compared to length of survival in the blood of a healthy individual. The paramecium test was used to determine blood toxicity of healthy subjects undergoing the most commonly used simulations of weightlessness for varying periods of time. Forty-one healthy males, aged 25-45, served as subjects. Group 1 (n=9) underwent 7 days of hypokinesia with head-down tilt (-8°); Group 2 (n=9) underwent 14 days of the same treatment; Group 3 (n=6) underwent 7 days of dry immersion; Groups 4 and 5 (n=9 and 8) underwent the same treatment as Group 2. For each group, except Group 5 which was tested daily, the paramecium test was performed in the baseline period, on days 3, 7 and 14 of hypokinesia, on days 1, 3, and 7 of immersion, and on day 3 of the readaptation period. The patterns of results of the paramecium tests were the same for all groups. Blood toxicity (as measured by decreases in survival time) increased under the simulation treatments and peaked on day 7, during the most intense period of adaptation, and subsequently levelled off slightly. This indication of increased blood toxicity associated with simulated weightlessness should be considered in the event of the occurrence of acute illnesses in space flight. In itself, the accumulation of toxic products, as an expression of compensatory-adaptive responses of the body to the adverse effects of space flight factors, is natural and does not require detoxification on board the spacecraft. Should the cosmonauts become ill, however, the presence of toxic substances in the blood could have a negative effect on the course and prognosis of the disease.

Figure Title: Changes over time in "toxicity" of blood plasma in the paramecium test in subjects exposed to hypokinesia with head down tilt and immersion

HUMAN PERFORMANCE

(See also: Biological Rhythms: P282; Psychology: P307)

PAPERS:

P286(6/86)* Kornilova LD, Smirichevskiy LD, Trutnev AV, Chekanova SL, Yakovleva IYa, Kravchenko SL.

Job performance (literally: professional work capacity) and functional state of an operator exposed to repeated optokinetic stimulation and head-down tilt.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 35-38; 1986.

[12 references; 1 in English]

Human Performance, Job Performance; Perception; Psychology, Functional State
Humans, Operators
Optokinetic Stimulation, Head-down Tilt; Neurophysiology, Vestibular
Tolerance

Abstract: This experiment investigated the effect of repeated exposure to optokinetic stimulation and head-down tilt on operator performance and state. The experiment took place in a training simulator. Subjects (16 healthy males, aged 25-45) were seated in a tiltable chair. Optokinetic stimulation is not specifically described other than as having been proven to elicit motion sickness. Head-down tilt was accomplished by tilting the top of the chair to -30° for 1.5 hours. The operator task involved eye-hand orientation of a target for heading, bank and pitch. Aside from speed and accuracy, dependent measures included: pulse, blood pressure, blood perfusion in the head as determined by impedance plethysmography, and cardiac interval parameters such as stress index, mode, amplitude of the mode, and variability. Severity of autonomic reactions was rated and frequency and rate of optokinetic nystagmus in the first minute after stimulation was measured. In addition accuracy of perception of spatial coordinates and of the vertical were recorded. In the first set of sessions, subjects were trained on the task and then participated in 16 practice sessions (twice a day at intervals of 1 - 3 days) until stable skills were acquired. In the second set of sessions, optokinetic stimulation was started 10 minutes before beginning of task performance and continued for 20 minutes during task performance. There were apparently 6 such sessions, but this is not stated directly, nor are intervals between them specified. In the third set of sessions, the subjects performed the task in the head-down tilt position for 1.5 hours. Again there appear to have been a total of six practice sessions. An interval of 2-2.5 or more months passed between the sets of sessions. Before each series, and 1 month after experiment completion, the level of task performance under normal conditions was monitored and vestibular and optokinetic tolerance were measured. After the first series of sessions, operator's task performance under 30 minutes of exposure to optokinetic stimulation was recorded. After the second and third series, task performance during exposure to optokinetic stimulation in head-down tilt position was measured.

Baseline studies identified 4 individuals with high levels of vestibular tolerance and 8 with high levels of optokinetic tolerance and 4 who had low tolerance for both stimulus sets. Of those tolerant of vestibular

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stimulation, 1 was intolerant to optokinetic stimulation, and of those tolerant to optokinetic stimulation 2 were intolerant of vestibular stimulation. After subjects had developed stable skills they were asked to perform the task during graded increases in optokinetic stimulation. In the optokinetically intolerant individuals, there was a statistically significant increase in errors in task performance, development of marked vestibular reaction, and an increase in pulse rate. The optokinetic and vestibular tolerant subjects (who apparently showed no such symptoms, not stated directly) showed an increase in the stress index from 96 to 142, while the intolerant subjects showed a decrease in the stress index. In the second series of sessions, involving repeated exposure to optokinetic stimulation, symptoms of motion sickness decreased, and task performance was restored in general. Tolerant individuals showed a moderate increase in cardiac stress index while intolerant subjects also showed an increase, but with greater fluctuation. During the test of both optokinetic and vestibular stimulation, tolerant individuals showed a significant increase in the stress index (apparently with no other effects), while intolerant individuals exhibited a decreased stress index, poorer perception of the vertical and increased fluctuations in blood pressure and pulse. Some of these intolerant subjects again suffered from symptoms of motion sickness and showed impaired task performance. After (apparently) 6 practice sessions with head-down tilt, task performance again improved and fluctuations in stress index decreased. Plethysmographic data indicated less blood flow in the vessels of the brain attributable to increased vascular tonus. However, after the practice sessions head-down tilt was combined with optokinetic stimulation, and task performance was again impaired and physiological reactions were evident, indicating that habituation to the two factors separately did not guarantee tolerance of their combined effects. Tests performed after all series of sessions were completed indicated a small increase in the tolerance of the previously intolerant individuals.

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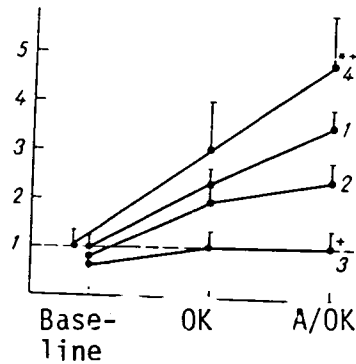


Figure Titles: Figure 1: Parameters of performance of manual orientation task in individuals with various levels of tolerance to optokinetic and vestibular stimulation during (OK) and after (A/OK) exposure to optokinetic stimulation

Here and in Figure 3: horizontal dotted line indicates level of parameter under normal conditions. Here and in Figures 2 - 4: 1 - vestibular tolerant subjects; 2 - vestibular intolerant subjects; 3 - optokinetic tolerant subjects; 4 - optokinetic intolerant subjects. * - differs significantly from baseline, $p < 0.05$; + - significant intergroup differences, $p < 0.05$.

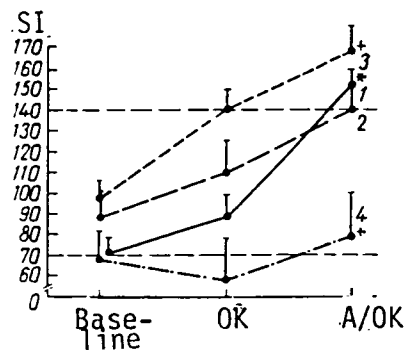


Figure 2: Changes over time in stress index while performing manual orientation task in individuals with various levels of tolerance to optokinetic and vestibular stimulation during (OK) and after (A/OK) exposure to optokinetic stimulation. Here and in Figure 4, horizontal dotted lines indicate normal range.

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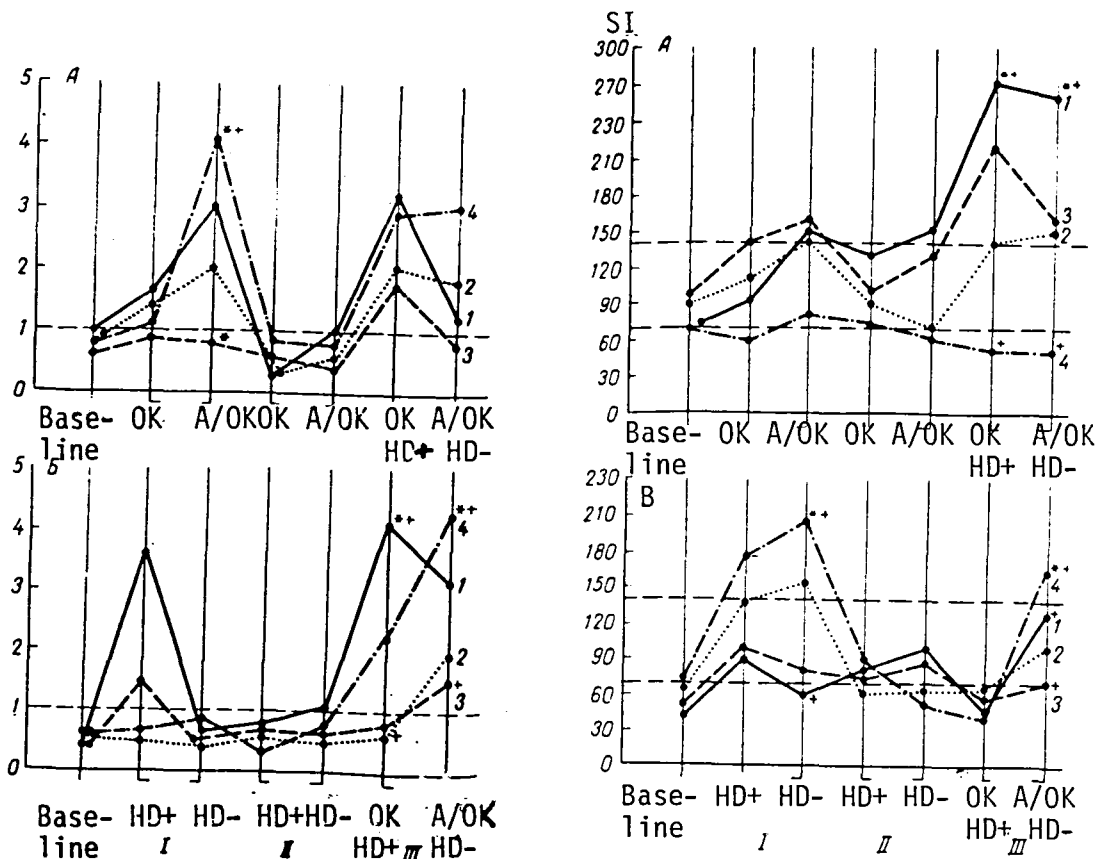


Figure 3: Errors in performance of manual orientation task (in degrees of roll) during habituation to optokinetic stimulation (A) and to head-down tilt (B).

HD+ and HD- - denote the beginning and termination of head-down tilt. Here and in Figure 3: I - first practice session; II - sixth practice session. III - test combining optokinetic stimulation and head-down tilt.

Figure 4: Changes in the cardiac stress index while performing manual orientation of a target during habituation to optokinetic stimulation (A) and to head-down tilt (B).

CONFERENCE REPORT:

CR2(6/86) Report on XV Gagarin Lectures -- Problems in Space and Aviation Psychology.

Krylova NV.

In: Psikhologicheskiy Zhurnal.

7(2): 158-161.

Key Words: Human Performance, Cosmonaut Performance, Performance Evaluation, Information Processing, Pursuit Tracking, ; Psychology, Space Psychology, Functional States, Psychophysical Assessment, Autogenic Training, Cosmonaut Training; Perception, Spatial Orientation, Signal Detection; Personnel Selection; Small Groups, Crew Compatibility

Participants in the "Problems in Space and Aviation Psychology" subsection of the 1985 Gagarin scientific lectures (under the direction of USSR pilot-cosmonaut and Candidate in Psychological Sciences G.T.Beregovoy, Doctor of Medicine, professor V.A. Ponomarenko, and Candidate of Biological Sciences N. V. Krylova) included psychologists, physiologists, engineers, mathematicians, and physicians, totaling more than 180 individuals. Sixty-seven papers and reports were presented and discussed.

The subject matter of these presentations can be classified as belonging to three basic categories: 1) theoretical and methodological issues in space and aviation psychology; 2) psychological aspects of training and performance; 3) clinical issues in the training of air- and spacecraft flight crews.

One of the relevant topics is the study of **spatial orientation in flight**. The results of theoretical and experimental investigations were presented in a number of reports (V.A. Ponomarenko with co-authors, N.A. Nosov, Yu.Yu. Shipkov, A.G. Fedorchuk, and others). A special flight experiment was performed to test and develop the ideas of N.D. Zavalova, which conceive of spatial orientation as an autonomous activity. The objective of this experiment was to investigate the role of active interaction between the cognitive representation of the reference image and acceleration cues arising through feedback from the performance of steering operations. The results of this experiment demonstrated that neither these cues in themselves nor their primary field of reception distort the incoming afferent impulses, but substantial mismatches between the position given by the reference image and the moment to moment flow of sensory information facilitates more efficient sensory adjustments. An important consequence of this finding may be new approaches to the development of psychophysical resistance to spatial disorientation. Spatial disorientation is one of the psychophysiological factors detrimental to the quality of flight crew performance. Level of spatial orientation capacity depends, to a significant extent, on individual differences and the degree of functional asymmetry between the brain hemispheres. Data concerning such asymmetry may prove useful in selecting operators to control dynamic systems and in predicting operator reliability on the job. It must be noted that the "gravitational picture of the flight" which is formed is directly related to the means which are used to facilitate orientation and this should be remembered when displays are designed.

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A large group of papers was devoted to theoretical and experimental research on various aspects of **operator performance**. V.A. Petrov and his coauthors examined issues related to sensorimotor coordination. In accordance with a structural and functional approach, the authors demonstrated that sensorimotor coordination is a special case of cognitive-executive coordination on a low (sensory) level of psychological representation. The results of their experiments made it possible to draw conclusions about the high level of demands placed on parameters of sensorimotor coordination by certain occupations and to refine a general mathematical model of operator performance. F.B. Berezin's paper considered multidimensional psychophysiological profiles and their use in predicting and evaluating level of operator performance. It is of interest that the nature and weighting of the elements in the multidimensional psychophysical profiles differ as a function of the performance criteria used to define the norming groups. The application of a systems approach to the psychophysical evaluation of information representation (V.A. Ponomarenko and co-authors) made it possible to formulate criteria for performing specific evaluations: 1) correspondence between the representation and the content of the pilot's task; 2) continued reliability in perception and processing of the information represented in the new display when environmental parameters change; 3) reliability of operator performance with the new display when his functional state changes. Multilevel evaluations of new methods of representing information were performed in order to determine the reasons for the difficulties pilots have experienced in using them and to derive requirements for optimizing the psychophysiological characteristics of information representation systems.

In their report, L. N. Popov and his coauthors present a system for studying operator performance using a microcomputer. This system automatically provides higher order [feedback] information to support the operator's performance, records the parameters and psychophysiological characteristics of this performance, and enables online processing of data. A.S. Zharov performed a study which used a general mathematical model of operator performance to identify the "quanta" of the control motions of a human operator. N.G. Ryl'skiy considered the formalization of information input to a model describing the performance of a trained operator from the standpoint of the principle of minimum subjective complexity. The selection of a means for representing visual stimuli in multiloop control tasks was discussed by A.V. Yefimov. It was demonstrated that an effective means for determining the best version of a visual display is to have operators use the displays for multiloop tracking tasks. In a study of the perception of digital information under conditions of computer controlled feedback, S.F. Sergeyev demonstrated the possibility of controlling the rate of visual perception. The studies by V.Ye. Yastrebov and S.M. Razinkin, and T.V. Isayevaya and A.A. Bezbogov were concerned with various aspects of the performance of a human operator as affected by a number of environmental factors, and also with individual differences in operator performance

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A number of papers examined compensation for and assessment of psychophysiological states on a general methodological level and with regard to various specific applications. V.I. Il'in related personality structure to self-correction of states and emphasized the importance of developing criteria on which to base individualized selection of compensation techniques. A special autogenic training system was included in anechoic chamber studies modeling the operator performance of **cosmonauts** in control, communications and visual observation systems during exposure to the major space flight factors (L.P. Grimak, A.K. Yepishkin). The speakers found that autogenic training had a beneficial effect, which may be attributed to elimination of adverse psychophysiological reactions elicited by extreme performance conditions and by mobilization of the body's adaptive reserves.

Assessment of the psychophysiological state of a pilot in emergency flight situations is an extremely important and urgent issue. Given our present lack of routine systems for monitoring the functional states of pilots, this is a rather difficult goal to achieve. I.M. Alpatov, et al. proposed an approach to psychophysiological assessment of the state of a pilot under emergency flight conditions, which includes methods for evaluating the pilot's state of health and personality, as well as the adequacy of his behavior and performance in emergencies with respect to specific flight situations. On the basis information obtained using this approach, the authors defined the correlation between the performance errors observed and particular changes in the functional state of pilots in flight. Analysis of this data can provide more reliable means to assess pilots' states under extreme conditions. L.P. Grimak and V.M. Zvonnikov considered the prevention and treatment of functional disorders in members of flight crews from the standpoint of psychotherapy, and propose the use of various types of autogenic training, as well as rational psychotherapy and hypnotherapy. V.A. Bodryy and V.V. Kharin described an investigation of the potential use of training simulators as a job-specific stress test of the rehabilitation of pilots who had experienced functional disorders of the nervous and cardiovascular system. Their methodology is based on simulation of instrument-guided flight and of typical problems which arise. The effectiveness of this methodology was demonstrated.

The success of a pilot's performance is a direct function of his abilities as revealed in the selection process. For this reason, it is extremely important that we improve the system, techniques and methodologies of **occupational selection of pilots**. A paper by Ye.D. Sokolova and A.Ch. Agayev described the use of a variety of psychological diagnostic methods to demonstrate the predictive validity of measures on the psychological adaptation of flight school students. V.I. Zvonnikov and B.A. Pokrovskiy considered the potential for improving the occupational selection of pilots and proposed a completely new approach which combines medicine and psychology. They emphasize the need to identify methods which can define the biological bases for occupationally relevant psychological traits, as well as of the adaptive reserves of the organism. The success of occupational selection in improving overall level of flight performance is monitored periodically by a **committee of flight medicine examiners**. A number of papers (by G.S. Mazanov, V.F. Volokhov, V.I. Byshkov, and I.M. Pimenov) presented methodological principles for performing clinical

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psychological assessments of flight crews during such examinations and for drawing psychophysiological conclusions concerning the individuals assessed.

The complex operator performances required by aircraft and space flight demand **special training**. A group of papers was devoted to research on individual components of operator performance. S.V. Yegorov and his coauthors studied the effect of visual monotony on psychological processes at various levels. It was established that the greatest susceptibility to monotony occurs during performance of operations involving perceptual regulation. The need to include additional tasks in the job as a means of keeping the operator's attention was demonstrated. A. Ya Abrazhevich and his coauthors performed research on the dynamics of signal detection performance. This study defined principles underlying changes in the latency and accuracy parameters of the operator's performance, taking account of the effects of spatial uncertainty, noise levels, individual differences, the functional state of the operators, and other factors. Methodological principles for optimizing signal detection performance under various levels of uncertainty were derived. A paper by V.V. Chumakov and A.N. Razumov examines the optimization of the interaction of the operator and multimodality information systems. The authors simulated emergency situations requiring active, goal-directed actions on the part of the operator. Analysis of experimental data showed that the optimal combination is an illuminated visual display of the relevant information with simultaneous verbal recommendations, produced through speech synthesis. The relationship between automation and image-based activity performed by an operator controlling a moving object was discussed in a paper by V.V. Lapa and V.V. Polyakov. Their experiments established that use of the automated mode for short periods (15-20 minutes) in control tasks is conducive to the formation of a psychological representation of the flight, suggesting that it is possible to use this as the major mode for short-term control of a moving object under complex conditions. I. B. Sokolova demonstrated that training for performance under especially complex (non-routine) flight conditions performed on training simulators must be supplemented by special psychological training to facilitate cosmonauts' development of the skills and abilities essential for successful performance under complex flight conditions.

A large group of papers was dedicated to the development of **methods for performing psychological research in cosmonautics and aviation**. O.I. Zhdanov believes that the most accessible methods for investigating the psychological aspects of the performance of specialized operators are those which are not based on special instruments, e.g., observation and interviews. A.V. Nikonov and L.V. Inozemtseva proposed a method for the psychological diagnosis of the functional state of an operator which analyzes the acoustic features of speech. V.N. Trofimov and V.F. Shevchenko suggest changes in the characteristic cardiac rhythm be used as a universal indicator of the tolerance of an operator to **space flight factors**. The relationship between objective and subjective methods of diagnosing functional states in humans was considered in a paper given by A.B. Leonova. She emphasized that subjective data can make a unique contribution to the process of psychological diagnosis and demonstrated that the success of any class of methods is a function of their

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suitability for specific diagnostic tasks. V.I. Pokhil'ko investigated the psychometrics of individual differences from the point of view of individualized psychological diagnosis. I.V. Smirnov and N.V. Gavrilova proposed methods for measuring the compatibility of operators who must work together for long periods of time under conditions of isolation. Their methods are based on evaluation of nonverbal interactions. G.L. Strongin and S.B. Shesterneva investigated the social climate in crews in civil aviation, and presented recommendations concerning staffing of flight crews so as to create and maintain a favorable psychological climate. To increase operators' visual work capacity, L.P. Grimak developed an ophthalmological autogenic training system. Evaluation of this method during 48 hours of continuous task performance confirmed its effectiveness.

A number of the papers presented were devoted to **specific topics of interest in aviation and space psychology**. L.G. Yeliseyeva discussed the aesthetic design of **cosmonauts' work clothes** from the point of view of psychophysiological comfort. She showed that the characteristics of work clothes have an influence on mood, which becomes particularly important during long-term space flights. She presented sketches of work clothes for cosmonauts which were designed on the basis of psychological and psychophysiological recommendations. I.S. Zamaletdinov and co-authors considered compatibility between flight controllers and communications operators on the one hand and pilots and cosmonauts on the other as revealed by psycholinguistic characteristics. They proposed specific methods for selecting and providing specialized training to controllers and operators in radiocommunications systems. A.N. Litsov reported on the effects of a continuous (sleep-deprived) work schedule on human adaptation to changes in work and rest schedules. The changes revealed by this study reflect the degree of tolerance of the human central nervous system to long-term sleep deprivation, along with aspects of the functioning of the circadian system. D.V. Gander described the psychological service in the air force, and discussed a number of its objectives and activities. B.M. Galeyeva reported on **musical programs for adaptation to weightlessness** and showed a demonstration film illustrating her hypothesis about the association between the perception of gravity and music.

This short overview of the material presented at the meeting should give an overall idea of the range of problems, both general and specific, in aerospace psychology. A number of encouraging facts should be noted: the participation of psychologists in Flight Surgeon's Medical Examination, expansion of the research on group behavior and psychological climate, and new emphasis on subjective methods of evaluation. A number of reports expressed new and interesting ideas about spatial disorientation, the use of personality tests to predict behavior in emergencies, and the rehabilitation system. It is important to emphasize the enthusiastic and active participation of the audience in discussion of the scientific papers.

LIFE SUPPORT SYSTEMS

(See also: Developmental Biology: P295)

PAPER:

P296(6/86)* Polyakov SV, Volgin VD, Sinyak YuYe, Maksimov YeD, Novikov VI.
Reclamation of wash water on long-term space flights by means of reverse osmosis.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 78-80: 1986.

[5 references; none in English]

Life Support Systems, Water Reclamation
Technique Demonstration
Reverse Osmosis

Abstract: Sorption has been the traditional means of removing residual impurities from wash water after filtration. However, since sorbents cannot be reused under space flight conditions, some other method of wash water reclamation is desirable. Membrane methods, particularly reverse osmosis, have become popular recently, and are especially appropriate for low concentration solutions like wash water. This experiment tested the effectiveness of the most selective membranes produced in the Soviet Union for water purification. The test solution was a mixture of catamine AB, and amine oxide, which were identified as analogues of the major contaminants of wash water. To better correspond with the composition of wash water, salt was added in a quantity equal to 40% of the catamine AB. Working pressure was 5 MPa. Permeability and selectivity of the membrane were studied for various concentrations of detergents. It was found that the permeability of the membrane decreased as detergent concentration increased. However, this decrease did not exceed 30%; membrane selectivity remained very high. A second experiment investigated reclamation of actual wash water using a number of methods (presumably sequentially). Wash water was passed through a filter, then through a reverse osmotic apparatus with a MGA-100 membrane and finally through a sorption column. Using this method it was possible to wash 33 times with an initial quantity of water of 30 l and an average usage of 10 l per wash. Consumption of sorbents was ca. 0.15% of the total of reclaimed water.

Tables: Table 1: Membrane permeability and selectivity as a function of detergent concentration

Table 2: Membrane permeability and selectivity as a function of concentration of detergent components, salt and water

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Table 3: Parameters of water during the reclamation process

Parameter	Stage in water processing			
	1	2	3	4
Bichromate oxidizability, mg O ₂ per 1 l	1332	264	45	10
Ammonium nitrate, mg/l	3.5	10	3.7	2
Chlorides, mg/l	44	44	8	3
Catamine AB, mg/l	78	18	3.5	0
Amine oxide, mg/l	96	48	12	0
pH	7.1	7.5	7.3	7.3
Transparency, cm	0	11	30	30
Color, degrees	10	10	10	10
Smell, rating (scale of 5)	5	4	2	0

1 - before filtration; 2 - after filtration; 3 - after reverse osmosis;
4 - after sorption.

P302(6/86)* Polonskiy VI, Lisovski GM.

Techniques for creating rapid growth strains of wheat for human life support systems.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 96; 1986.

Abstract: Note: this is the full translation of abstract cited as describing a paper deposited in the All-Union Scientific Research Institute for Information in Medicine and Medical Technology and All-union Institute for Scientific and Technical Information.

Life Support Systems, CELSS
Botany, Wheat, Strain Development
Light Tolerance, Photosynthesis

The solution of the important problem of reducing the size of the greenhouse required by a spacecraft may be the cultivation of plants using intensive light levels higher than those provided by the Sun on Earth, in conjunction with the use of highly productive types of plants specially developed for space flight. With the aim of discovering light-tolerant and highly productive forms of plants, we selected wheat variety 232 on the basis of the amount of grain on each ear and evaluated the plant for the tolerance of its photosynthetic apparatus to high levels of light. The wheat was cultivated hydroponically in claydite in a hermetically sealed plant container with light intensity equal to 1300 W/m^2 . Under exposure to high levels of light, some individual plants markedly exceeded (by a factor of 1.6-2.0) the mean amount of grain on an ear. Seeds from these plants were selected to be the source of the next generation. As a result of repeating this selection process for four generations, we identified strain No 5. The fifth and sixth generations of the new strain were compared with the variety 232 plants with light levels equal to 800-1300 and 500-600 W/m^2 , respectively. A physiological evaluation of the plants allowed us to conclude that the moisture parameters were higher in strain No 5 than in variety 232: the upper leaves of the experimental plants had 11% higher moisture content, 13% less of a water deficit and 25% of the diffusion resistance compared to variety 232 plants. The concentrations of chlorophyll and carotinoids and also the proportion of weakly bound chlorophyll "A" in the leaves of strain No. 5 were substantially higher than in the initial variety of wheat. The greater tolerance of the photosynthetic apparatus of plants of strain No. 5 to high light intensity allowed these plants to develop greater overall biomass and to produce a higher yield of grain. When strain 5 plants were sown with a density of 4,000 per m^2 and light intensity was 800-1300 W/m^2 , over a the 65-day growth period a yield of grain of 5 kg/m^2 was obtained, as opposed to 3.5 kg/m^2 for the initial variety. Given the yield obtained from strain No. 5 under high levels of light, the amount of photosynthetically active radiation required to provide a human with all the oxygen, water and grain (400 g/day) he needed would be equal to the amount of sun falling perpendicularly on an area of 6 m^2 . The work cited demonstrates clearly that, even when only one variety of wheat is involved and a limited number of traits are used as the basis for selection, selection of plants is one of the possible ways to increase the rate of photosynthesis in the phototropic link of a life support system. [2 tables; 12 references]

MONOGRAPH:

M78(6/86) Kovrov BG, Kordyum VA, editors.
 Mikroorganizmy v iskusstvennykh ekosistemakh
 [Microorganisms in artificial ecosystems].
 Novosibirsk: Nauka; 1985.
 [192 pages]

Institute of Biophysics, Siberian Division, USSR Academy of Sciences

Key Words: Life Support Systems, CELSS, Microbiology, Chlorella, Algae, Closteriopsis, Bacteria, Yeast, Botany, Crepis, Arabidopsis Welsh Onion, Orchid, Pea, Wheat, Space Flights, "Salyut-6," "Salyut-7," Mathematical Modeling

Annotation: In the papers in this collection are based mainly on material presented at the XIIth All-Union working meetings on the issue of metabolism in closed ecosystems (1983), data are cited concerning the growth of microorganisms in such systems and in their individual links. The behavior of microbiological subjects in simulated laboratory conditions and on board spacecraft is described. Principles governing their growth, biochemical, and metabolic processes are analyzed.

The book is intended for microbiologists, plant physiologists, and specialists in space biology.

In lieu of contents we are presenting translations of the brief abstracts of each of the included papers.

1. The effects of space flight factors on higher plants

The viability and mutability of plants after space flight. Vaulina EN, Anikeyeva ID, Kostina, LN. This paper cites data from experiments performed on board the "Salyut-6" and "Salyut-7" orbital stations with air dried seeds of Crepis capilaris (L) Wallr. and Arabidopsis thaliana (L) Heynh, sprouts of C. capilaris obtained under flight conditions, and on flowering plants of A. thaliana. It is demonstrated that decrease in the germinating ability of seeds, the viability and fruitfulness of the plants, and the increase in their mutability are direct functions of time spent in storage on Earth and in space. These results may be attributed mainly to the effects of the heavy component of cosmic radiation and to the depression of the reparative capabilities of cells under space flight conditions. [3 tables; 16 references; pp 5-10]. See Botany: P235, Issue 6; Botany: P281, Issue 7.

The effect of auxin on mutational variability and growth activity in plants after exposure to space flight factors. Alekperov UK, Mekhti-zade ER, Nechitaylo GS, Nagiyeva DN. This paper describes the effects of auxin (IUK) on spontaneous and space-flight induced mutational changes and rate of mitosis and growth of Welsh onion plants. The effects of auxin on the process of cell proliferation and the possibility of stabilizing the level of spontaneous mutability of hereditary structures are demonstrated. It is noted that exposure to space flight factors depresses mitosis and increases mutational variability in the organisms studied. A negative correlation was found between the level of mutability and the growth of the organism. The authors discuss the significance of the hormones to regulation of genetic competence to control the vital

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activity of the organism under favorable environmental conditions. [2 tables; 11 references; pp. 11-14] See Botany: P306, Issue 7.

Modifications by alpha-tocopherol of the mutational process in Welsh onion seeds exposed to long-term space flight. Aliyev AA, Alekperov UK, Mashinskiy AL, Askerov IT, Akhundova DD, Oreshkin VI, Ismaylov KA. This paper establishes that space flight factors significantly increase the frequency of structural rearrangements of chromosomes and decrease the level of proliferation in air dried seeds of the Welsh onion. Alpha-tocopherol modifies both the spontaneous and the induced mutational process, having a protective effect and lowering the level of chromosome aberrations, and also stimulates mitosis. [2 tables; 5 references; pp. 15-18]

Structural and functional description of cells of the protonema of the moss Funaria hygrometrica exposed to long-term clinostasis. Nedukha YeM, Ovrutskaya II. This paper establishes the heterogeneity of cellular reactions to the effects of microgravity. It identifies the specific changes in the structure of plastids, cell walls, increases in the population of microbodies, and the appearance of potassium binding by cell membranes. It considers the possible mechanisms regulating cellular adaptation to microgravity. [9 references; pp. 19-22]

The ultrastructure of the root cap of Arabidopsis plants under normal conditions and microgravity. Tarasenko VA. This paper describes the ultrastructural organization of cells of the root cap of cress (Arabidopsis thaliana (L.) Heynh. race Enkheim) under normal conditions, horizontal clinostasis (2 rotations/min.), and during actual space flight on board the scientific orbital complex "Salyut-6". It establishes that clinostasis changes the topography and structure of plastids and increases rate of vacuolization in cells of the central statenchyme. Local damage to the integrity of the tonoplast, zones of lysis in the mitoplasm and cell walls, and the absence of large starch grains in the amyloplast of the statocytes were noted. It is hypothesized that the changes found in the space-flown cells were caused by the overall effects of long term weightlessness and the subsequent shift to terrestrial gravity. [11 references; pp. 23-28]

Morphological and functional state of the photosynthesis system of plant cells grown for varying periods under space flight condtions. Abilov ZK, Alekperov UK, Mashinskiy AL, Fadeyeva SI, Aliyev AA. This paper describes the study of leaves of the orchid Epidendrum radicans and the pea Pisum sativum, grown for 110 and 29 days respectively under space flight conditions. The morphological state of cell organelles was studied. Spectral characteristics of the pigment components, the absorption spectra and flourescence spectra were analyzed in the leaves of experimental and control plants. Changes were identified in the structure of the chloroplasts, in the degree of saturation of the stroma of the ribosomal structures, and in the organization of the intrachloroplast membranes of the system. [pp. 29-31]. See Botany: P181, Issue 4; Botany: P221, P222, Issue 5.

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2. One-celled algae as the photosynthesis link in ecological systems

The effects of space flight factors on Chlorella. Slashcheva NK, Vaulina EN, Anikeyeva ID. An experiment on the orbital space complex "Salyut-6-Soyuz" studied the viability, mutability and course of development during postflight cultivation of active and passive cultures of Chlorella vulgaris, line LARG-1, exposed to space flight. It was demonstrated that exposure to space flight factors for 18 days did not influence the viability or mutability of an active culture. In a number of experimental variations, a statistically significant increase (in comparison with controls) was found in the number of damaged microcolonies. [2 Tables; 2 references; pp. 32-34] See Microbiology: P182, Issue 4.

An experiment in the quantitative assessment of specific immunofluorescence of the pyrenoid, as a gigantic carboxysome. Markelova AG, Shapiguzov YuM, Vladimirova MG, Semenen'ko VYe. Clear specific luminescence of an intact pyrenoid was demonstrated with two cultures of one-celled algae, testifying to the presence of a significant quantity of ribulose diphosphate carboxylase (RDPC). The preliminary results of the use of various techniques for quantitatively assessing the content and location of the RDPC in the compartments of the algae chloroplasts are cited. This study confirms earlier results indicating that the major concentration of RDPC is localized in the pyrenoid. [3 figures; 2 tables; 10 references; pp. 35-40]

Long-term storage of one-celled algae in a collection without periodic reculturing. Vladimirova MG, Salamatova LV, Lyubimova YeD, Markelova AG. It is demonstrated that culture collections of Chlorella may be kept for prolonged periods without reculturing when they are in a relatively closed system. Thermophilic cultures can be stored for 12 months and mesophilic for 15-20 months. [5 illustrations; 1 table; 20 references; 41-52]

Steroid compounds in one-celled algae. Klyachko-Gurvich GL, Tauts MI, Semenen'ko VYe. This paper reviews recent data on the qualitative components and quantitative concentration of steroid compounds, mainly sterols, found in algae belonging to various taxons under various cultivation conditions. Experimental data are presented concerning the discovery of terpenoid and steroid compounds differing from sterols in Chlorella cells. [3 figures; 1 table; 23 references; 53-61]

On the adaptation of one-celled algae and tissue cultures of higher plants to microgravity conditions. Sidorenko PG, Zhad'ko SI, Popova AF, Karnaukh IM, Il'in VP. This paper considers the initial reactions of one-celled plant organisms -- Chlorella algae and cultured cells of Haplopappus -- to exposure to microgravity, studied using the chemiluminescence method. It is shown that clinostasis leads to periodic oscillations in the intensity of chemiluminescence. It was noted that one-celled plant organisms show great capacity to adapt to microgravity, making them good prospects for use as components of closed ecological systems. [2 figures; 4 references, pp. 61-65]

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The submicroscopic organizations of Chlorella cells, growing for 9 days on board the "Salut-6." Popova AF, Kordyum YeL, Nechitaylo GS. This paper demonstrates the similarity between the major features of submicroscopic organization of flight and control cells of Chlorella of the autotrophic line LARG-1. Certain disruptions in the process of cytokinesis, along with a decrease in the number of reserve polysaccharides, were found in the experimental cells. It is concluded that space flight conditions do not have an inhibitory effect on a developing Chlorella culture if the exposure time is short. [8 references; pp. 66-70]

Antibacterial activity of microalgae as a function of illumination.

Maksimova IV, Sidorova OA. This paper describes intensification of the antibacterial effect of the green marine algae Westella botryoides attributable to light. The data suggests that this effect is related to the emission of substances into the medium which increase their antibacterial activity in response to light. [3 figures; 8 references; pp. 71-73]

Genetic consequences of exposure of Chlamydomonas to the herbicide diuron. Kvitko KV, Khakimov YaI. This paper demonstrates that the genetic effects of diuron (N=3,4-dichlorophenyl-N-N-dimethylurea) are a consequence of its physiological effects (blocking the function of the chloroplast). No mutagenic effect on Chlamydomonas was found. Weak effects of diuron on one-parent inheritance are analogous to the decrease in the number of copies of chloroplast DNA. The mutagen nitrozo-guanidine? induced nuclear and plastid mutation and decreased the frequency of transmission of chloroplast genes from the (+) type of zygote pairing by 70-90%. [1 table; 17 references; pp. 74-81]

The effect of a nitrogen source in the medium on the carbohydrate composition of Chlorella in intensive continuous cultivation. Nefedova YeL. Krasotchenko LM. This paper demonstrates that the total concentration of carbohydrates, including assimilable ones, is higher on potassium nitrate by 18-20% and 14% as compared to 11-13% and 9% per unit of dry material. It was found that the synthesis of carbohydrates by Chlorella grown on potassium nitrate occurs against a background of decreasing concentration of protein, and when ammonium nitrate is used there are decreases in the concentrations of protein and lipids. It is concluded that when the chlorella is to be included in a human biological life support system it is desirable to cultivate them on potassium nitrate. [1 table; 82-83]

A study of the biological value of bleached algae (Scenedesmus) in an experiment using animals. Abakumova IA, Gur'yeva TS, Tresvyatskaya NA. The biological value of the biomass of one-celled algae (Scenedesmus) was studied in an experiment using rats. The amino acid composition of the protein of the Scenedesmus was determined, as was the digestibility of trypsin in vitro of bleached and unbleached biomasses. The results of this research with animals showed no substantial changes in the parameters of protein metabolism, digestibility of food, or weight in comparison with the analogous parameters of a control group given casein as a protein source. [pg. 84]

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A comparison of the growth of algae in weightlessness using living and fixed material. Sychev VN, Galkina TB, Kondrat'yeva YeM, Gavrish TG. In experiments with cultures of Chlorella, line LARG-1, growing under space flight conditions, it was demonstrated that growth continued after the capsule had landed. While samples were being obtained in the laboratory, the mean size of the cell increased (in comparison with those fixed at the landing site) by 2-16%, and their number increased by 4-37%. It is concluded that algae grown in weightlessness do not stop growing on return to gravity. [1 table; pp. 85-86]

A study of growth rate and photosynthesis of Closteriopsis acicularis var. africana Hind as a function of the major physical characteristics of the environment. Levinskikh MA, Meleshko GI, Lebedeva YeK. The growth and development of the one-celled algae Closteriopsis acicularis var africana Hind was studied as a function of temperature, illumination, and concentration of CO₂ and O₂ in the atmosphere of the reactor. It was demonstrated that this type of algae in high density populations is capable of tolerating extreme environmental conditions. It is suggested that Closteriopsis has great potential for use in biological life support systems, including those intended for humans, and for mass production cultivation. [5 Figures; pp. 87-90]

The growth and development of algae in cumulative cultivation after exposure to weightlessness. Sychev VN, Galkina TB, Kondrat'yeva YM, Krasotchenko LM. Results from experiments in the cultivation of Chlorella, line LARG-1, showed no differences between flight and control conditions in the time or phases of population development. It is concluded that all of the processes underlying the regulation of changes in population in flight cultures of algae are the same as those in ground-based controls. [3 figures; pp.91-92]

Mineral nourishment of dense populations of Euglena. Livanskaya OG, Pokrovskaya YeI. A technique for delivering supplemental solution containing ammonia in a hermetically sealed reactor is described. [pp. 93-94]

Gas exchange characteristics of an intensive culture of Closteriopsis acicularis var. africana Hind. Levinskikh MA. The gas exchange characteristics of the one-celled algae Closteropsis acicularis var. african Hind. were studied under conditions of intensive cultivation. The function relating the increase in biomass, absorption of carbohydrates and emission of oxygen was identified. Any of these characteristics may be used for controlling the major parameters of the nutrient medium in continuous cultivation of algae in systems that are closed with respect to gas exchange. [1 reference; pp. 95-96]

Regulation of the synthesis of rubulose-1,5-bisphosphatcarboxylase and its subunits in cells. Kasatkina TI, Vedeneyev AN, Semenenko VYe. An investigation of the synthesis of rubulose-1,5-bisphosphatcarboxylase and its subunits was performed under conditions of experimental repression (by introduction of 2-desoxy-D-glucose) and induction of synthesis of this enzyme. It is demonstrated that, in the transitional processes of repression and induced synthesis of the enzyme in Chlorella cells, subunits of rubulose-1,5-bisphosphatcarboxylase coded in the chloroplast and nuclear genomes develop differently. [4 figures; 9 references; pp. 97-102]

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3. Research on models of biotechnological life support systems

Utilization of the principle of dominant indicator for the development of complex biotechnological life support systems. Danilov VN, Likhogrudova LYe, Mashinskiy AL, Travkin VI. This paper proposes a method for developing variants of biotechnological life support systems, and evaluating them by means of the totality of indicators of dependent variables, when the structure of the system is indeterminate, and information on the quantitative values of the component indicators is incomplete. [1 table; 5 references; pp. 103-114]

Gas balance in an electrolysis -- hydrogenous bacteria system. Semenov YaV, Golubokovich AV, Revenko SK, Paleyeva MA, Boruzdina MA. Investigations determining the coefficient of gas assimilation in an electrolysis hydrogenous bacteria system established that the coefficient of assimilation corresponds to the human respiratory coefficient when the concentration of bacterial cells in the apparatus is between 5.5 and 30.6 g (absolute dry biomass)/l. It is demonstrated that the coefficient of assimilation may be controlled by regulating the concentration of hydrogenous bacteria cells in the apparatus. [1 table; 3 references; pp. 115-116]

The potential use of cell cultures from higher plants in a life support system. Sidorenko PG, Martyn GM, Mikeladze GG, Podlutskiy AG. This paper examines the biological properties of cultivated higher plant cells from the standpoint of their selection as components of life support systems. Data is cited on obtaining cell cultures from cotyledons of soy beans and peas, tubers of Jerusalem artichokes, cabbage, broccoli, dill, and basil leaves, and calculating their growth curves. The potential use of cultured cells from higher plants for nutrition in life support systems is discussed. [7 references; pp. 117-120]

Biological testing of the atmosphere in closed ecosystems using micro organisms. Kovrov BG, Tirranen LS. It was demonstrated experimentally that one can evaluate the state of the atmosphere of a closed ecosystem on the basis of differences in size of experimental and control colonies of microorganisms selected for sensitivity to anthropogenic and technogenic pollution. [1 table; 6 references; pp. 121-123]

On the use of edible mushrooms in artificial ecosystems including humans. Pan'kova IM, Trubachev IN, Kochetova GI, Manukovskiy NS, Bayanova YuI, Abrosov NS, Gribovskaya IV. This paper examines the possibility of cultivating edible mushrooms on wheat straw in an artificial ecological system. Nine species of mushrooms are compared with regard to degree of oxygenation of the substrate, lignolytic activity, yield, and biochemical composition. Certain technological aspects of cultivating mushrooms in an artificial life support system are considered. [1 figure; 1 table; 8 references; pp. 124-129]

The effects of volatile metabolites of microorganisms on the production of volatile metabolites of other cultures. Kovrov BG, Tirranen LS. This paper describes the experimental demonstration of the fact that volatile metabolites of some microorganism cultures can induce production of volatile biologically active substances by other cultures. It was found that to

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enhance the effects of volatile metabolites it is essential to take into account the individual properties and ages of both the inducing and the target culture. [1 illustration; 1 table; 4 references; 130-133]

Evaluating the composition of the biomass of Chlorella and its energy content in a model of a "man - algae - mineralization" biological life support system. Antonyan AA, Sukhova NI. This paper describes the evaluation of the biomass of algae and its energy content on the basis of the heat of combustion in a model of a "man -- algae -- mineralization" biological life support system. It was found that Q_{calc}/Q_{exp} varies as a function of the degree of reduction of the algae's biomass (R). It was found that the quantity Q is stable in a continuous cultivation mode when a closed cultivation technology used with Chlorella. [1 figure; 1 table; 134-136]

An approximation methodology for investigating the productivity dynamics of a biological life support system when the cultivation conditions are changed. Savkin VI. This paper describes an approximation methodology for the theoretical study of productivity dynamics in a biological life support system when the cultivation conditions are changed. A mathematical model of a system based on one-celled algae cultivation was used to evaluate the accuracy of this method and results are described. This method may be used to solve problems related to evaluation of the efficiency of biological life support systems. [9 figures; pp. 137-142]

The formation of a microbial community as the photoautotrophic link in human biological life support systems. Yunusova LS, Kondrat'yeva YeM, Drugova NA. This work studied the effects of certain aspects of closed systems on the formation of a microbial community serving as the photoautotrophic link in a biological life support system. The microflora of wheat plants and microalgae of the reactor were studied in an experiment with a closed "man -- wheat -- algae" system. Maximum microflora population was attained when the plants were in the sprouting phase; the population of bacteria in the algae reactor was maintained at the level of 300-900 million bacteria/ml. The microbial community of the ecosystem was generally stable. [1 figure; pp. 143-145]

4. Processes and apparatus

A system for processing the biomass of lower plants for utilization as fodder and food. Frenkel' LI, Morozov GI, Tikhomirov YuA. This paper considers issues related to the design of a system for breaking down the cell membrane of one-celled algae in order to increase its assimilability for use as food for humans and fodder for domestic animals. This material could be useful in the creation of artificial life support systems. [1 figure; pp. 146-147]

A technique for removing traces of the cultivation medium from lower plant cells. Frenkel' LI, Morozov GI, Kamin'skaya YeG, Yazdovskaya VI. This paper examines a process for repeatedly washing the cells of one-celled algae with distilled water to remove traces of the cultivation medium. It is demonstrated that desorption of the elements of the medium stops after the fifth washing cycle. [2 tables; pp. 148-150]

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The effects of illumination conditions on the development of mycelia and fruit bodies of Pleurotus. Klyushkina NS, Chevardova NP, Kharitonova YeA, Babayeva YeV. This paper describes an investigation of the effects of various illumination conditions on the development of fruit bodies of a traditional edible mushroom -- Pleurotus, and on the development of mycelia in its two species, and on certain other edible xylosaprotrophs??. It was demonstrated that in the first stage of development (development of mycelia) it is best to cultivate the mushrooms in the dark, while at the stage of formation of fruit bodies short periods of dim illumination are desirable. [2 tables; 2 references; pp. 151-153]

An investigation of the growth of microorganisms on media with hydrolyzates of plant wastes. Boruzdina MA, Paleyeva MA, Semenov YaV. The growth of Candida scottii yeasts and Alcaligenes eutrophus Z-1 hydrogen oxidizing bacteria in media containing hydrolyzates of beets, potatoes and tomatoes was studied. It was found that the yield of yeast biomass reached 73.5% of the consumed reducing substance in the medium, while the yield of hydrogen oxidizing bacteria was 65.8%. On a mixture of hydrolyzates the yeast yield reached 79%. [3 tables; 5 references; pp. 154-156]

Experiments in purifying waste water from the production of nutrient yeasts using Chlorella. Andreyeva RA. Results are cited from investigations of the dynamics of changes in concentration of pollution in waste water which had been used as a medium for the cultivation of Chlorella. [2 tables; 1 figure; 2 references; pp. 157-159]

Chlorella as the protein substrate for nutritive media used in medical microbiology. Khvosten'ko TI, Bendas LG, Al'bitskaya ON, Gridneva NI. The technology for processing Chlorella microalgae to obtain a protein hydrolyzate is described, and its potential use to supply all the protein required for the production of bacteriological nutritive media is demonstrated. [3 tables; 1 figure; 2 references; pp. 160-165]

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A mathematical model of the oxygenation of wheat straw by microorganisms. Manukovskiy NS, Abrosov NS, Kosolapova LG. This paper proposes a mathematical model of the process of oxygenation of lignocellulose from wheat straw by microorganisms. The principles identified through use of the model made it possible to explain the reasons for incomplete oxygenation of the substrate during the process of biodegradation. It is demonstrated that the observed effect is related to the shift of the growth of the microorganisms from polysaccharides to lignin. [3 figures; 3 references; pp. 166-171]

Some aspects of the electrophoretic separation of microorganisms. Shishkov YuI. Separation of various cultures of microorganisms was attained using preliminary electrophoresis in a density gradient. Elution of their partition fractions and subsequent cultivation made it possible to establish a correlation between electrophoretic mobility and productivity. [2 tables; 2 references; pp. 172-175]

Microbiological decomposition of plant wastes on a solid substrate under artificial conditions. Shepelev YeYa, Shaydorov YuI, Popov VV. This paper describes a study of the decomposition of straw surrounded by compost and an inert substrate and fertilized every month for three years. It was shown that, after the formation of a soil destruction biocomplex (6 months), the rate of decomposition of straw becomes commensurate with the rate of its formation on an identical area in a greenhouse. This has implications for the creation of a higher plant link utilizing ecological self-regulation mechanisms controlling the processes of decomposition and transformation of organic wastes. [8 references; pp. 176-183]

MATHEMATICAL MODELING

(See also: Biospherics: M77; Body Fluids: P305; Neurophysiology: P299)

PAPER:

P278(6/86) Gusev VMGB, Kislyakov VA.

Interaction of the otolith organ and the semicircular canals in an angular stabilization system applied to a human being in space.

Biofizika.

XXXI(1): 123-127; 1986.

[7 references; 3 in English]

I.P. Pavlov Institute of Physiology, USSR Academy of Sciences, Leningrad

Mathematical Modeling, Computer Simulation, Stabilization System

Human

Neurophysiology, Otolith Organs, Semicircular Canals

Abstract: An earlier work developed the theory that a system for stabilizing a solid object in space requires sensors to measure: 1) the vector of angular speed of the body's rotation, and 2) the vector of deflection with respect to an absolute coordinate system. This paper offers a mathematical model of a biological system for providing angular stabilization in space, with the required sensors having parameters approximating those of the human otolith organs and semicircular canals. This model was implemented on a computer and a number of stimulation conditions were modelled. For each case, the contribution made by each of these sensors was assessed. The displacement of endolymph in the six left and right semicircular canals is modeled as a function of the vector of angular acceleration with a system of differential equations, using physiologically appropriate parameters. These parameters are: pressure vector in the canals, density of endolymph, area occupied by the i th canal, projections of the perpendicular of the i th canal on three fixed axes (one of which corresponds to the local vertical) at the start of angular displacement, coefficient of elasticity of the cupula in the canals, diameter of the canals, coefficient of friction, coefficient of viscosity of the endolymph and length of the canal. Excitation of the otolith membrane is modeled as a function of the following: linear acceleration proper (including acceleration of free fall), vector of absolute angular rate of the rotation of the body, distance of the membrane from the center of rotation, vector of membrane displacement (modeled as a function of the projection of the vector of linear acceleration on two perpendicular axes of membrane sensitivity), coefficient of elasticity of the membrane, and rotation matrix of the vector in an absolute coordinate system. Results of the computer simulation indicated that the process of stabilizing the human body can only be modeled if it is assumed that the system of semicircular canals and the otolith organs work together. The semicircular canal system enables the stabilization mechanism to work properly for short intervals and when acute changes in exogenous stimulation occur, while the otolith organ is essential for stabilization under conditions of long-term gradual changes in stimulation.

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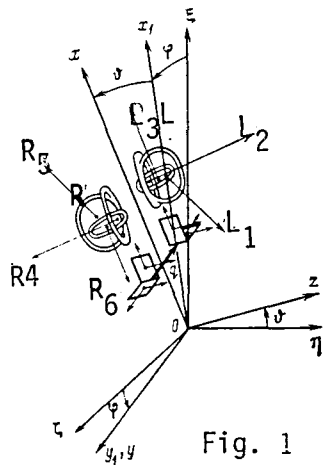


Fig. 1

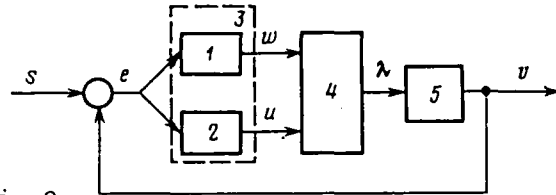


Fig. 2

Figure Titles: Figure 1: Position of absolute and dynamic coordinate axes and diagram of the orientation of the plains of the semicircular canals and plains of displacement of the membranes of the otolith organ in the left (L) and right (R) halves of the vestibular apparatus. The arrows designate the directions of the perpendicular to the planes of the semicircular canals and the axes of sensitivity of the membranes; q is the vector connecting the arbitrarily selected centers of the right and left halves of the otolith organ.

Figure 2. Overall diagram of the biological angular system for stabilization in space: 1 -- otolith organ, 2 -- semicircular canals, 3 -- vestibular nerve centers, 5 -- stabilized object.

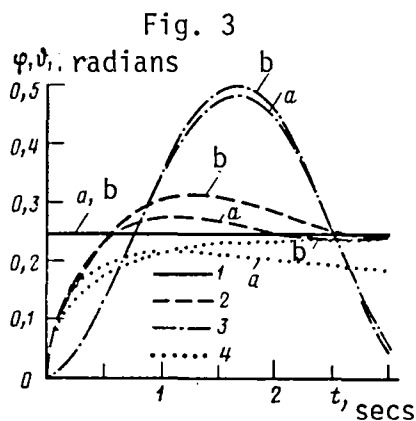


Fig. 3

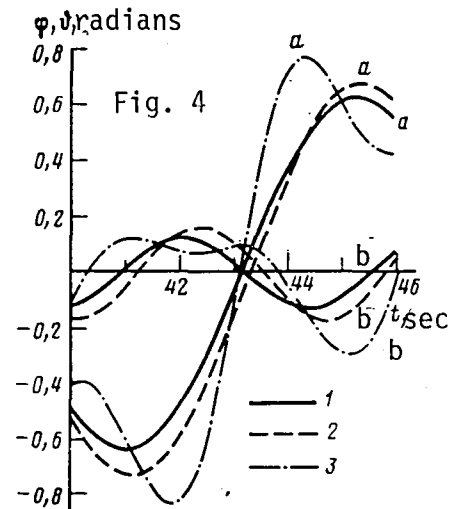


Fig. 4

Figure 3. Reactions of the stabilization system to angular disturbance in the form of a sudden change 1 in exogenous stimulation. The reactions of the stabilization system: 2 -- joint functioning of the semicircular canals and otolith organ; 3 -- otolith organ alone; 4 - semicircular canals alone; a and b are the stabilization processes for angles φ and θ

Figure 4: Reaction of the stabilization system to periodic exogenous stimulation; designation as in Figure 3.

METABOLISM

(See also: Neurophysiology: M84; M85)

PAPERS:

P289(6/86)* Popov IG, Latskeyevich AA.

Free amino acids in human blood in the initial period of exposure to hypokinesia with head-down tilt.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 46-54; 1986.

[5 references; 2 in English]

Metabolism, Amino Acids, Blood; Nutrition, Cosmonaut Rations

Humans, Males

Hypokinesia, Head-down Tilt

Abstract: Previous studies have documented the effect of hypokinesia with head-down tilt of -4° on the concentration of amino acids in venous blood. The present study used a head-down tilt angle of -10° in subjects who ate a diet identical to that provided for cosmonauts in space. Seventeen healthy males, aged 20, participated in this study, which involved a 7-day period of hypokinesia. Venous blood was taken in the morning on an empty stomach in a baseline period, at the end of days 3 and 7 of hypokinesia, and on day 7 in the rehabilitation period. Amino acids in the blood were determined using ion exchange chromatography. During the preliminary and readaptation periods the subjects ate a standard diet, consisting of from 3000-4000 calories; during hypokinesia they received the daily rations used for cosmonauts, consisting of 118.2 grams of protein, 389.1 g of carbohydrate, 101.8 g of fat and totaling 2794.9 calories. The initial amino acid level in the subjects' blood differed somewhat from the norms for healthy adult males, which is partially attributed to their relative youth. The main differences involved lower than normal levels of valine, methionine, and alanine, and higher than normal levels of threonine, phenylalanine, and lysine.

At the end of day 3 of hypokinesia, concentration of all acids, with the exception of tyrosine, alanine and glycine, were elevated significantly with respect to baseline concentration, although these levels generally remained within the physiological norms. The greatest increases occurred with leucine, methionine, lysine, threonine, serine, arginine, cystine, glutamic acid and histidine. At the end of the seventh day of hypokinesia, concentrations of all amino acids were significantly higher than they had been in the baseline period, although not all were higher than they had been on day 3. The total concentration of essential amino acids was significantly higher than it was during the baseline period and on day 3. Total level of nonessential acids did not differ significantly from that on day 3, but was higher than baseline levels. The acids which had increased the most compared to the baseline period were lysine, methionine, leucine, threonine, isoleucine, valine, serine, aspartic acid, histidine, cystine and glutamic acid. Seven days after the termination of hypokinesia, the majority of acids had dropped to a concentration lower than or equal to their initial values, with the greatest decreases being for valine, lysine, threonine, tyrosine, histidine and glutamic acid. Acids which occurred in higher than baseline concentrations were: methionine, leucine, isoleucine and aspartic acid.

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The total concentrations of both essential and nonessential acids were slightly below baseline. The authors conclude that the level of amino acids in blood plasma during hypokinesia with head-down tilt indicates that protein supply to the body during this condition is high, which would allow dietary protein to be decreased if necessary.

Table Titles: Table 1: Concentrations of free amino acids in the blood plasma of subjects in the baseline period

Table 2: Concentrations of free amino acids in blood plasma of subjects after 3 days of hypokinesia with head-down tilt and a diet consisting of cosmonaut rations

Table 3: Concentrations of free amino acids in blood plasma of subjects after 7 days of hypokinesia with head-down tilt and a diet consisting of cosmonaut rations

Table 4: Concentrations of free amino acids in blood plasma of subjects during the rehabilitation period

P301(6/86)* Zezerov AYe, Ivanova SM.

A polarographic method for measuring the products of lipid peroxidation in the plasma and erythrocytes of humans and laboratory rats.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 94-95; 1986.

[16 references; 3 in English]

Metabolism, Lipid Peroxidation, Products in Blood

Human, Rats

Measurement, Polarography

Abstract: This paper determined the concentration of primary molecular and terminal products of lipid peroxidation in the plasma and erythrocytes of humans and rats, using a mercury drop electrode. It was determined that concentration of lipids was higher in the erythrocytes than in the plasma of both species studied. This method was evaluated by the authors as useful in the study of free radical oxidation responses to exposure to extreme factors.

Table and Figure Titles: Table: Level of products of lipid peroxidation in plasma and erythrocytes of humans and animals

Figure: Typical polarograms of lipids in plasma and erythrocytes

MONOGRAPH:

M79(6/86) Furdyy FI, Khaydarliu SKh, Mamalyga LM.

Kombinirovannyye vozdeystviya na organizm ekstremal'nykh faktorov.

[Effects of combinations of extreme factors on the body].

Kishinev: Shtiintsa; 1985.

[142 pages; 15 figures; 11 tables; 407 references; 109 in English]

Institute of Zoology and Physiology, Moldavian Academy of Sciences

Key Words: Metabolism; Hypoxia, Hyperthermia, Hypokinesia; Radiobiology, Radiation

Annotation: This monographs synthesizes the authors' own experimental results with extensive data from the literature relevant to the problem of the functional and metabolic capacities of humans and animals exposed to the combined effects of certain extreme stimuli. Analyses are presented of the reactions of individual cellular structures and visceral organs to exposure to hypoxia in combination with other types of extreme stimuli, and also during convulsive seizure of various etiologies. Particular emphasis is placed upon the quantitative evaluation of shifts in certain components of the protein biosynthesis system in cellular structures. It is shown that interrelationships in the neuroglia system determine not only the nature and parameters of the participating factors, but also the properties of the morphofunctional organizations of the specific neural formation. Possible mechanisms underlying the effects of exposure to combinations of stimuli are examined. This book is intended for physiologists, biochemists, pathophysiologists and practitioners in general and sports medicine.

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 - 2.5 Physical exertion and hyperthermia (56)
 - 2.6 Effects of radiation in hyperthermia (61)
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3. Neurochemical reactions to exposure to combinations of extreme factors (90)
4. Mechanisms regulating metabolism during exposure to extreme factors (109)

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MICROBIOLOGY

(See also: Life Support Systems: M78)

PAPER:

P279(6/86) Opalinskaya AM, Agulova LP.

The effect of cosmic, solar, and geophysical factors on the agglutination of bacteria in vitro.

Biofizika.

XXXI(1): 94-98; 1986.

[10 references; 1 in English]

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Microbiology, Bacteria, Agglutination

Bacteria, Salmonella typhosa

Biospherics, Cosmic, Solar and Geophysical Factors, Radiobiology, Neutron Irradiation, Geomagnetic Effects

Abstract: Agglutination of bacteria, as a heterogenous system in disequilibrium, is an appropriate model for investigating the effects of cosmic, solar and geophysical factors on living systems. Typhoid bacteria (Salmonella typhosa) were selected as subjects; standard agglutinating nonadsorbed typhoid serum was used as the antibody source, while group ON diagnosticum was used for the antigen. Standard immunological methods were used. The research was performed in 1973 and 1974, and between 1977 and 1980, initially using a visual rating scale and subsequently a photoelectric colorimeter-nephelometer. A high optical density (D) was associated with a low level of bacterial agglutination, and vice versa. Measurements were recorded daily. Association between the independent factors studied and agglutination was examined using linear and nonlinear correlation and the superimposed epochs?? method. The independent factors examined were: Wolf numbers, mean radiation flux at 202 MHz, mean daily values of intensity of neutron components of cosmic rays corrected for pressure, critical frequency of the ionospheric layer, daily magnetic activity and amplitude of micropulsations in Earth currents, and season of the year. To test the importance of variation in electromagnetic fields, some cultures were shielded by steel and permalloy. The strongest association found was between neutron components of cosmic rays and agglutination; this association was positive in each year except 1979. For the other independent variables association varied in magnitude and direction from year to year. It is hypothesized that changes in the sign of correlations are associated with changes in the level of solar activity. Agglutination was found to be greater in the summer than in other seasons, this may be associated with seasonal changes in levels of the other factors. When the Earth passes through sector boundaries of the interplanetary magnetic field, a number of geophysical parameters change. Bacterial agglutination is concluded to vary as a function of the polarity of the field; when the Earth is in a negative sector, agglutination appears to be higher than when it is in a positive sector. Geomagnetic disturbances, variations in cosmic rays, and fluctuations in the radioactivity of the atmosphere are known to follow a 27-day cycle; the authors discerned a tendency for bacterial agglutination to cycle within the same period. A statistically insignificant tendency for agglutination to increase following magnetic storms was also noted. When bacterial cultures were shielded from fluctuations in external electromagnetic fields by steel or permalloy, agglutinative reactions were

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decreased relative to nonshielded cultures. The authors concluded that overall their results indicate that bacterial agglutination is sensitive to cosmic, solar and geophysical factors. Electromagnetic effects are singled out as particularly important.

Table and Figure Titles:

Table: The Effects of [Electromagnetic] Shielding on Bacterial Agglutination

Condition	n	x	Statistical Parameters				
			$\pm m$	sd	v	t	F
Control	60	0.621	0.001	0.015	24.9	< 0.05	< 0.001
Steel shield	60	0.627	0.001	0.01	16.6		
Control	60	0.621	0.001	0.015	24.9	< 0.01	< 0.001
Permalloy shield	60	0.634	0.001	0.009	14.5		

Key: x - arithmetic mean value of the optical density of the reaction mixture; $\pm m$ - standard error of the mean; sd - standard deviation; v - coefficient of variability; n - number of measurements; t - Student's t significance level; F - Fisher coefficient significance level

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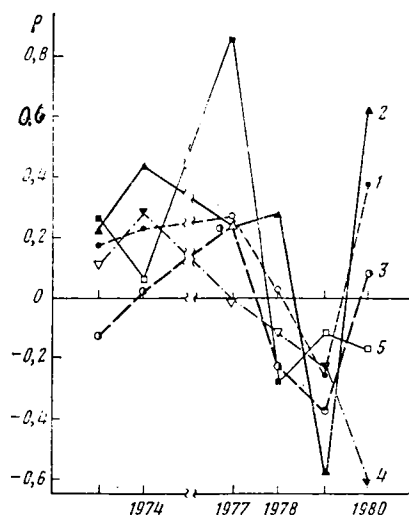


Figure 1: Correlation coefficients of the daily values of the results of agglutinative reactions and indicators of cosmic, solar and geophysical factors. Filled-in symbols indicate statistical significance of the correlation with $p < 0.05$ to $p < 0.001$. r is the Spearman correlation coefficient. 1 - Wolf number; 2 - neutron component of cosmic rays; 3 - mean solar radiation flux at 202 MHz; 4 - critical frequency of ionospheric layer; 5 - daily magnetic activity

Figure 2: Yearly changes in rate of bacterial agglutination and cosmic, solar and geophysical indicators. A - agglutination 1973, 1974, 1977 - 1980. Abscissa: months; ordinate: deviation from the mean

Figure 3: Changes in rate of bacterial agglutination and values of indicators of cosmic, solar and geophysical activity when polarity of interplanetary magnetic field changes.

Figure 4: Changes in rate of bacterial agglutination as the sun revolves on its axis

Figure 5: Effect of geomagnetic storms on rate of bacterial agglutination

MUSCULOSKELETAL SYSTEM

(See also: Biological Rhythms: P282; Cardiovascular and Respiratory Systems: M81)

PAPERS:

P293(6/86)* Belkin VSh, Astakhov OB.

Capillaries in skeletal muscles of white rats during adaptation to high altitudes in Pamir and the Antarctic.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 65-69; 1986.

[9 references; 0 in English]

Musculoskeletal System, Skeletal Muscles, Capillaries

Rats

Adaptation, High Altitude, Hypothermia

Abstract: This study utilized 180 male outbred white rats in three locations: a control group at 810 m above sea level; one group in the Pamir mountains, near the Afghanistan border, at 4000 m above sea level; and one group in the Central Antarctic 3488 m above sea level. The animals in all three groups were maintained under normal laboratory conditions. Rats were sacrificed on days 1, 3, 7, 14, 21, 28 and 41-45 of exposure to high altitude. Histological samples were taken from the quadriceps muscles and morphometric study of muscle capillarization was performed. Measurements, made on a 1 mm² section, included: number of capillaries and muscle fibers; total length and diameter of capillaries and fibers; volume of capillaries and nerve fibers; ratio of capillary volume to muscle fiber volume; and number of capillaries in a single muscle fiber. After one day in Pamir (4000 m), there was loosening of connective tissue surrounding the veins and arteries, spasms of individual arteries, sharp increases in the diameter of the capillary lumens and decrease in their density. The mean number of capillaries in a single fiber decreased. Despite the increase in the total capillary volume, these changes suggest a decrement in the amount of nourishment each fiber received. In the next period, lasting from 3-14 days, further changes indicative of the development of morphological signs of circulatory disruption were noted. Individual fibers showed disappearance of transverse striation, fragmentation, and partial degeneration. Clusters of lymphoid cells were observed in connective layers. Beginning on day 3, capillary density increased, as did capillary diameter and length, leading to a substantial increase in the total volume of capillaries in a section of tissue. The highest value of the ratio between capillary and muscle fiber volume occurred on day 14. In the subsequent period (21-45 days), the following changes were noted: irregular hyperemia of the veins, sites of loosening of the perivascular connective tissue, and complete disappearance of sites of dystrophic and necrobiotic destruction of myocytes. The state of muscle capillarization is described as demonstrating stabilization at a new level. This is confirmed by signs of substantial increase in diameter of capillary lumens and total capillary volume. In the Antarctic, changes were quite different in spite of the similarity in altitude. During the first three weeks, while signs of tissue degeneration were marked, only isolated signs of changes such as occurred in Pamir were observed in intramuscular blood vessels. There was substantial constriction of capillary diameter, and

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decrease in total volume and number of capillaries per fiber on days 3, 7 and 14. On days 28-41, signs of adaptation began to occur, tissue degeneration decreased, capillary diameter, density, and total volume increased, indicating improved muscle capillarization. The authors postulate that the differences in the time course of adaptation at the two high altitude sites could be partially explained with reference to the length of time involved in transporting the Antarctic subjects to the study site.

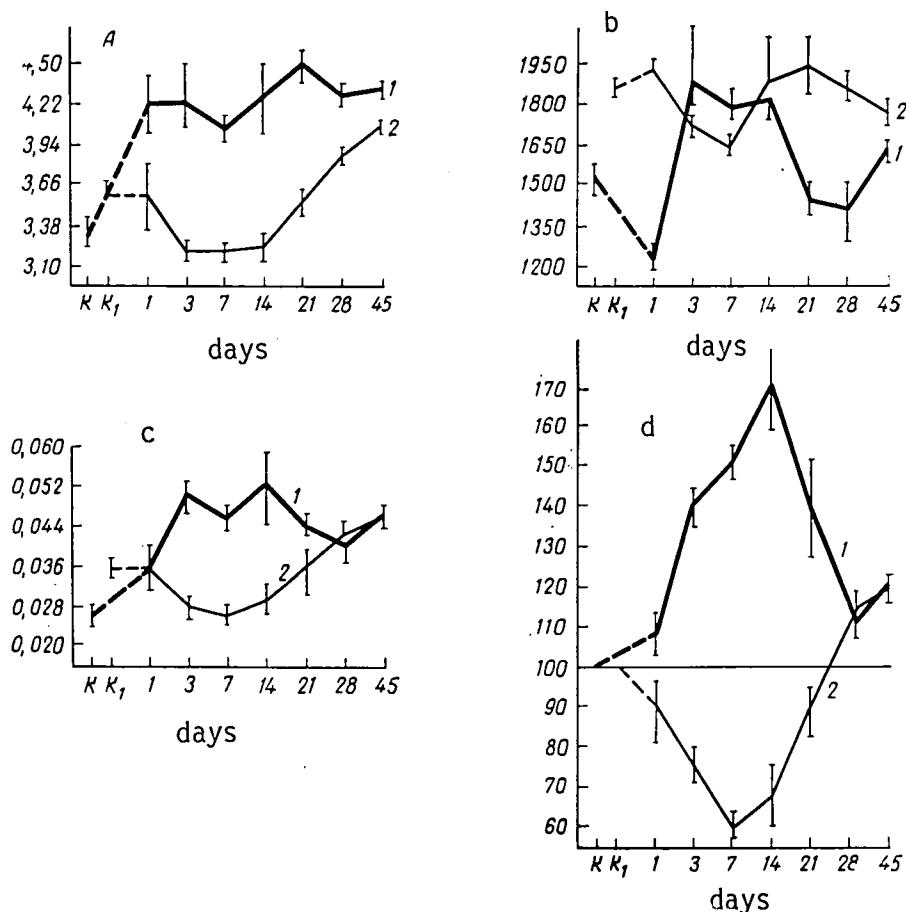


Figure Titles: Time course of morphometric parameters of capillarization of the quadriceps of white rats during adaptation to high altitude conditions in Pamir (1) and the Antarctic (2).

A - diameter of capillaries (in μm); B - number of capillaries in 1 mm^2 of a section surface; C - total volume of capillaries (in mm^3 ; D - relation of volume of capillaries to volume of muscle fibers (in %); K - control at 840 m; K₁ - antarctic baseline.

Figure 2: Sites of polymorphous cellular infiltration in connective layers/strata of the quadriceps muscle of white rats on day 14 of exposure to altitude of 4000 m above sea level

Figure 3: Distension of myocytic venules with fragmentation. Quadriceps of white rats on day 7 of exposure to altitude of 3488 m in the Antarctic

P298(6/86)* Burkovskaya TYe.

The effect of hydrocortisone on the osteogenetic function of bone marrow of mice.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 83-86; 1986.

[17 references; 13 in English]

Musculoskeletal System, Bone Marrow, Osteogenesis

Mice, Male

Endocrinology, Hydrocortisone

Abstract: Bone marrow was implanted under the kidney of male mice. One half the amount of bone marrow in the femur of a donor from the same litter was used. Two conditions were used to investigate the differential effects of hydrocortisone on osteogenic precursor cells, as well as on mature osteoblasts. In the first, hydrocortisone was administered to the donor 1, 3 or 5 days before marrow was extracted. In the second condition, hydrocortisone was administered once to the recipient 1, 3, 5, 10 or 14 days after the cell transplant. In addition, 7 mice were given hydrocortisone 6 times, every 3-4 days starting on day 3 after transplantation. The hydrocortisone was injected intraperitoneally in a dose of 5 mg per animal. Recipient mice were sacrificed on day 22 or 23 after the cell implantation. The overall appearance and weight of the transplants were assessed and the thymus and spleen were removed and weighed. Smears of marrow from the ectopic bone were stained and the relative concentrations of the major hemopoietic cells were determined. A single injection of hydrocortisone to the donors or to the recipients in the first 3 days after transplant had no significant effect on the osteogenic function of the bone marrow. When hydrocortisone was injected on days 5 to 10 after transplant, weight of newly formed bone was decreased by approximately one half compared to that of control rats receiving no drugs. Rats receiving hydrocortisone two weeks after implantation, when bone tissue in control rats was already well formed, showed a decrement of approximately 25% in ectopic bone mass. Repeated injections of hydrocortisone virtually prevented formation of ectopic bone. The lack of effect of hydrocortisone injected in the tissue donor or in the recipients on the first day after implantation indicates indirectly that osteogenic precursor cells are relatively resistant to hydrocortisone. The authors argue that hydrocortisone depresses the proliferative activity of such cells. Under all conditions where transplant recipients received hydrocortisone, the weight of the spleen and thymus were significantly depressed. This effect was most pronounced when the drug was injected on days 10-14 after the transplant, coinciding with the greatest depression in weight of the ectopic bone. Analysis of the hemopoietic activity of marrow in the ectopic bone demonstrated depression of lymphopoiesis when hydrocortisone was administered. However, this effect was less pronounced (in percentage terms) than that of thymus involution. Changes in the number of erythroid and granulocytic cells appears to be short-lived, peaking at day 10 after transplant and essentially disappearing by day 14. The authors argue that these results indicate that increased hydrocortisone production associated with the stress of space flight may contribute to effects of weightlessness on bones. They state that at present it is difficult to determine whether the effects of hydrocortisone on histogenesis of bones are direct or indirect.

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Table Titles: Table 1: Heterotopic bone formation (day 22-23 after implantation of cells under the kidney capsule)

Table 2: Cytological composition of bone marrow in ectopic bone (major hemopoietic elements, in %)

Condition	Day of Injection	Erythroid Elements	Granulocytes	Lymphocytes
Control	--	26.05	35.65	34.15
HC injected	1	26.35	37.36	27.70
in donor	3	21.25	42.50	33.50
(before trans-plant)	5	25.50	41.87	26.93
HC injected	1	29.93	41.67	24.40*
in recipient	10	18.64**	51.14**	25.64**
(after trans-plant)	14	32.55*	40.66	23.00**

* $p < 0.05$ in comparison with control

** $p < 0.01$ in comparison with control

NEUROPHYSIOLOGY

(See also: Human Performance: P286; Mathematical Modeling: P278)

PAPER:

P299(6/86)* Kondrachuk AV, Sirenko SP.

A mathematical model of the cupulo-endolymphatic system with varying densities of the cupula and endolymph.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 86-92; 1986.

[15 references; 9 in English]

Neurophysiology, Vestibular System, Cupulo-endolymph System

Mathematical Modeling

Rotation, Hydromechanics

Abstract: This paper describes a new mathematical model of the biophysics of the vestibular apparatus, developed with the ultimate goal of determining the causes of and mechanisms underlying motion sickness under space flight conditions. One of these causes may well be disruption of the functioning of the semicircular canal as a hydromechanical transmitter. The present work describes a model of the cupula-endolymph hydromechanical system and simulates the following features: 1) the semicircular canal as an isolated torus with rigid walls filled completely with homogeneous viscous liquid (endolymph) with a given density, 2) a cross section of the canal which is completely blocked by a piston (cupula), with a density different from that of the endolymph, attached to the wall of the torus. The endolymph is treated as an idealized liquid and a term for representing linear viscous friction is introduced into the equation representing piston motion. The behavior of such a system is mathematically modelled when it is rotated at a given angular velocity along an axis a given distance from the center of the torus. On the basis of the dynamics of this system it is conjectured that differences in the density of the cupula and endolymph may be one of the factors leading to vestibular symptoms in the presence of altered gravitational conditions.

Figures: Figure 1: Semicircular canal systems

Figure 2: Semicircular canal

Figure 3: System of toroid coordinates and terms used in the derivation of equations for motion of the cupula-endolymph system

Figure 4: Orientation of the rotation axis and gravitational vector relative to the plane of the torus

MONOGRAPHS:

M84(6/86) Samoylov MO.

Reaktsii neyronov mozga na gipoksiyu

[Reactions of neurons in the brain to hypoxia.]

Leningrad: Nauka; 1985.

[190 pages; 61 figures; 544 references]

I.P. Pavlov Institute of Physiology (Laboratory of Functional Morphology and Physiology of the Neuron), USSR Academy of Sciences

Key Words: Neurophysiology, Brain Neurons, Hypoxia, Ischemia; Cytology, Metabolism, Cellular, Calcium

Annotation: This monograph examines methodological issues pertinent to the study of the reaction of neurons in the brain to hypoxia. The author, on the basis of his own experimental results (obtained using a combination of methods based on in vivo microscopy) and data from the literature, has identified a number of principles governing structural, functional and metabolic damage to neurons arising in response to various types of hypoxia. Modern ideas about the mechanisms underlying the triggering and formation of intracellular reactions in response to oxygen insufficiency and ischemia are summarized. Particular emphasis is placed on disruption of the integral redox state of the neurons, and on calcium ion metabolism within them. The author demonstrates that the nature of the response of neurons to hypoxia depends on their initial functional state, rate of metabolism, and the particular features of neurovascular relationships. Arguments are presented to justify the position that neurons in the brain retain their viability for a long period after termination of oxygen supply, despite their high sensitivity to oxygen insufficiency.

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M85(6/86) Bulygin IA, editor.

Tsentral'nyye mekhanizmy neyrogumoral'noy regulyatsiya funktsii v norme i patologii

[Central mechanisms of neurohumoral regulation of functions in the norm and in pathology].

Minsk: Nauka i Tekhnika; 1985.

[248 pages; 40 tables; 65 figures; 317 references; 85 in English]

Byelorussian Academy of Sciences

Key Words: Neurophysiology, Central Nervous System, Medulla Oblongata, Nuclei, Neural Mediators; Endocrinology; Metabolism, Lipids; Cardiovascular and Respiratory System, Circulation, Systemic and Brain, Ischemia; Adaptation, Rotation, Vibration, Radiation, Thermal Regulation

Annotation: This monograph presents new data in support of the hypothesis that the unity and interaction of divergent and convergent phenomena is a general principle pervading the organization and functioning of the central nervous system. The results of investigations of the role of vestibular nuclei of the medulla oblongata as a central link in the formation of neurohumoral reactions to dynamic factors are presented. Ideas are developed concerning the role played by neural mediators in the brain and pyrogenic substances in thermal regulation and regulation of the metabolism of fatty acids and lipoproteins in the blood. The effects of the disruption of systemic and brain blood circulation on certain structural and functional parameters are analyzed. This book is intended for physiologists, morphologists, and clinicians, particularly, neuropathologists and psychiatrists.

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NUTRITION

(See also: Metabolism: P289)

PAPER:

P294(6/86)* Sivuk AK, Kasatkina AG, Strukova YeI, Naydina VP, Zharkovskaya YeYe.

The effect of long-term storage on certain parameters of the fat component of freeze-dried food products.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2): 69-72; 1986.

[14 references; 0 in English]

Nutrition, Freeze-dried Food, Fat Content

Chemical Analysis

Storage, Long-term

Abstract: Several freeze dried dishes (buckwheat porridge/kasha/, mashed potatoes, and stewed cabbage) to which fat had been added during preparation were packed and wrapped in individual portions weighing 25-50 g in an inert atmosphere, and then stored at air temperatures of $20 \pm 5^{\circ}\text{C}$ and relative humidity of 70-80%. The products were evaluated for appearance, consistency, taste, color and odor, both in freeze-dried and reconstituted form, before storage and on months 6, 10 and 14 of storage. In addition, total content of fat, presence of primary and secondary products of fat oxidation, and concentration of fatty acids were determined. Sensory quality of reconstituted products was evaluated as high throughout the experimental period. Fat content decreased somewhat over the period, while content of free fatty acids increased. The authors attribute these changes to partial hydrolysis. Peroxide content increased in the first six months and then began to decrease for two of the dishes. At all times the foods were within government standards for immediate consumption, but not for further storage. The dishes were also tested for rancidity by measuring the accumulation of secondary products of lipid oxidation. Throughout the storage period such products grew cumulatively. Fatty acid content was determined by gas chromatography and showed that for the cabbage and potatoes there was a gradual decrease in the proportion of unsaturated fatty acid and an increase in saturated fats. In general, the buckwheat and potatoes underwent fewer changes than the cabbage, possibly due to the presence of natural antioxidants.

Figure Titles: Figure 1: Change in the acid number of the fat component of dishes under storage

Figure 2: Change in the peroxidation number of the fat component of dishes under storage

Figure 3: Change in the degree of oxidation of the fat component of dishes under storage

Figure 4: Chromatogram of methyl esters of fatty acids obtained from buckwheat kasha and mashed potatoes

PERCEPTION: See Human Performance: P286, CR2
PERSONNEL SELECTION: See Human Performance: CR2

PSYCHOLOGY

(See also: Human Performance: P286; CR2)

PAPER:

P307 (8/86) Simonov PV.

Some theoretical principles for evaluating and developing methods for controlling and compensating for the effects of emotions on cosmonaut performance.

Uspekhi Fiziologicheskikh Nauk.

17(2):20-30; 1986.

[31 references; 12 in English]

Institute of Higher Nervous Activity and Neurophysiology, USSR Academy of Science, Moscow

Human Performance, Cosmonaut Performance

Humans, Cosmonauts

Psychology, Emotions, Stress

Abstract: This paper discusses the principles of the so-called "need-information" theory of emotions, which (at least according to its developer) has been widely acknowledged as ideally suited to problems in cosmonaut psychology. In brief, this theory postulates that the origin, nature, and intensity of emotions are determined jointly by a felt need and a subjective assessment of the probability of satisfying that need. Such probability assessments can occur on either a conscious or unconscious level. In the latter case the emotion is perceived as the direct result of the current situation, although it is actually the result of complex predictions performed by the brain. The needs (motivations) on which emotions are based can be classified into three major groups: vital, social and "idealistic needs" (e.g., for knowledge and creation). Individuals differ as to which needs are dominant most of the time. Aside from the needs in the three major groups, individuals vary in the strength of their needs for mastery and to overcome obstacles. The author uses his theory to derive recommendations for preventing excessive emotional stress and its potentially adverse effects on cosmonaut performance. Rational cosmonaut training, he claims, would combine development of the appropriate motivational structure with maximum saturation of pragmatic information concerning routine and emergency flight situations. Not only will such information help to identify appropriate measures for coping with the situation, but by diminishing subjective uncertainty will prevent negative emotions from interfering with task performance. With regard to training and, by implication, selection, the author emphasizes that it is the "task-oriented" cosmonaut, i.e., one who has strong positive motivation to overcome obstacles and achieve mastery, who will perform best in flight. In evaluating cosmonauts emotional state, the author recommends against exclusive reliance on performance measures, since these may, by effort of will, mask the true state of tension, especially in individuals trained in "self-regulation" techniques. As the physiological cost of self-regulation increases, unforeseen breakdowns in performance become more likely. Thus, the author recommends the use of involuntary direct physiological measures, such as heart rate. He further

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discusses the desirability of using measures which do not require that special transmitters be attached to the body, complicating task performance and possibly having negative psychological effects. Two such potential methods, which he recommends, are the recording of eyelid movements (possibly using miniature transmitters attached to the frames of glasses) and of the acoustic parameters of speech, its rate and level of intelligibility. To associate speech parameter values with particular functional states, aside from using individuals demonstrated by other parameters to be in certain states, the author recommends use of actors trained in the Stanislavsky method.

RADIOBIOLOGY

(See also: Biospherics: M82; Developmental Biology: P295; Exobiology: P280; Metabolism: M79; Microbiology: P279; Neurophysiology: M85)

PAPERS:

P283(6/86) Gabrielyan ES, Akopov SE, Kharatyan AA, Petrosyan AK.
Prostaglandin control of thrombocytic and vascular hemostasis in irradiation.

Byulleten' Eksperimental'nyy Biologii i Meditsiny

CI(1): 79-81; 1986.

[11 references; 6 in English]

Scientific Research Sector of Radiobiology, Armenian Ministry of Health

Endocrinology, Prostaglandin, Synthesis, Antiaggregation Properties;
Stability; Hematology, Thrombocytes, Hemostasis
Rats, Rabbits
Radiobiology, ^{60}Co

Abstract: The purpose of this study was to investigate the effect of plasma proteins and erythrocytes on the stability of PGI_2 during irradiation. Experiments were performed using 180 Wistar rats and 12 rabbits. Acute radiation sickness was induced with ^{60}Co irradiation in doses of 6 and 5.45 Gy for rats and rabbits respectively. Stability of PGI_2 in blood plasma was assessed on the basis of maintenance of prostaglandin's antiaggregative properties after 10 minutes of incubation in the plasma, and the capacity of the erythrocytes to destroy PGI_2 was assessed on the basis of decrease in the antiaggregation effect by stabilized albumin PGI_2 after 5 minutes of incubation with erythrocytes. Aggregation of erythrocytes was determined using an instrument designed by the authors. By day 1 after irradiation, antiaggregative activity of vessel walls had decreased noticeably in rats. This decrease was most pronounced on days 7-10 and by day 14 showed some tendency toward normalization. The plasma of irradiated animals showed a marked decrease in stabilizing effect which continued to drop over a 1-week period. On the other hand the PGI_2 -decomposing capacity of the erythrocytes of irradiated animals increased. This capacity peaked on day 7 after irradiation. The authors conclude that the disruption of prostaglandin control of the functional state of the thrombocyte-vessel wall system in response to irradiation results not only from decreasing synthesis of PGI_2 in the vessels, but also from decreased stability of PGI_2 in circulation, and acceleration of its decomposition resulting in a decrease in the period during which it is effective at facilitating thrombocytic/vascular hemostasis. This must be taken into account in developing pharmaceutical means for treating hemorrhage. Evidently, in irradiation the rapid decomposition of PGI_2 in blood may substantially limit its therapeutic effect, requiring adjustments of dosage and modes of administration.

Figure Titles: Figure 1: Antiaggregative effects in the aorta of rats

Figure 2: Changes in the stabilizing capacity of plasma proteins and prostoglandine destroying capacities of erythrocytes in irradiated rabbits and rats

P304(6/86)* Davydov BI.

Safety standards for electromagnetic radiation in the radio frequency range.

Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina.

20(2):15-23; 1986.

[32 references; 16 in English]

Radiobiology, Safety Standards

Human Exposure, Review Article

Radiation, Electromagnetic Radiation, Radio Frequency Band

Abstract: This paper reviews safety standards for human exposure to electromagnetic radiation in the radio frequency band in a number of Soviet bloc and western nations. Maximum acceptable dosage for exposure to radiation for frequencies above 30 MHz are considerably lower (i.e., standards are more stringent) in the USSR than in the West, both for the population in general and for those dealing with such radiation in their jobs. The author claims that these standards require revision and suggests 0.4 W/kg as the maximum acceptable dose rate, corresponding to an energy flux density of 100 V/mp² for frequencies over 2 GHz. The author emphasizes the psychological and economic disadvantages of exaggerating the dangers of nonionizing radiation at these frequencies.

Tables and Figure: Table 1: Classification of electromagnetic radiation

Table 2: Maximum acceptable levels of electromagnetic radiation in the radio frequency band for the general population in various countries
[Note: to conserve space, data for Poland and Britain omitted from this table.]

Country	f, MHz	I, W·m ⁻²	E, V·m ⁻¹
USSR	0.03-0.3(LF)	1	20
	0.3-3 (MF)	0.25	10
	3-30(HF)	0.04	4
	30-300(VHF)	0.01	2
	300-300,000(U,S&EHF)	0.05(0.15-0.25)*	4(8-10)*
USA	0.01-300,000	10	60
	0.01-300,000 **	0.5	14
IRPA/INIRC (recommended)***	0.1-1	20	87
	> 1-10	20/f	87/f ^{1/2}
	> 10-400	2	27.5
	> 400-2000	f/200	1.375·f ^{1/2}
	> 2000-300,000	10	60

* Numbers in parentheses refer to short-term standards for intermittent pulsed observational radar for the bands 10, 23 and 35 cm.

** Recommendations (New York, Public Health Agency)

*** International Committee on Non-ionizing Radiation, International Radiological Protection Association

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Table 3: Standard levels of electromagnetic radiation for continuous and intermittent irradiation during job performance (computed for an 8-hour day) in the USSR, Poland and Czechoslovakia

Note: To conserve space, only data on USSR are presented here.

Country	f, MHz	I, $W \cdot m^{-2}$	E, $V \cdot m^{-1}$
USSR	0.06-3	7	50
	3-30	1	20
	30-50	0.25	10
	300-300,000*	0.25(2.5)	10(30)

Note: Numbers in parentheses refer to intermittent or pulsed field.

* $t(r)=2/I$: $t(r)=20/I$ (intermittent).

Table 4: Proposed safety standards for electromagnetic radiation (continuous and intermittent irradiation) in the radio frequency band in the US, Great Britain, Canada and West Germany (8-hour working day)

Note: To conserve space, data on Great Britain, Canada and West Germany are omitted here.

Country	f, MHz	I, $W \cdot m^{-2}$	E, $V \cdot m^{-1}$	H, $A \cdot m^{-1}$
US*	0.3-3	1000	600	1.6
	3-30	9000/f	1800/f	5/f
	30-300	10	60	0.16
	300-1500	f/30	3.5	$9.4 \cdot 10^{-3} f$
	1500-100,000	50	340	0.36
IRPA/INIRC	0.1-10	100	194	0.51
	> 1-10	100/f	$194/f^{1/2}$	$0.51/f^{1/2}$
	> 10-400	10	61	0.16
	> 400-2000	f/40	$3 \cdot f^{1/2}$	$0.008 \cdot f^{1/2}$
	> 2000-300,000	50	137	0.36

* Acceptable dose 144 J/kg for every 0.1 hour (0.4 W/kg per 0.1 hr).

Figure 1: Ratios of acceptable levels of energy flux density (for an 8-hour work day) in two groups of countries (USSR, Poland, Czechoslovakia, and US, Great Britain, Canada)

SPACE MEDICINE: SPECIAL FEATURE

"The hard road to the stars: In commemoration of the 25th anniversary of the first manned space flight." Round table discussion in Meditsinskaya Gazeta, 11 April 1986, No. 30 (4579). By V. Pishchik, Yu. Faybishenko.

Tomorrow the entire world will mark the 25th anniversary of the first manned space flight. No matter how impressive are today's achievements in the exploration of space and despite the considerable advancement of our understanding of the complex interactions between man and this very unfamiliar environment, the first and thus most difficult steps taken at the dawn of the era of man in space formed the foundation for these successes.

Not long before this anniversary, those who took these first steps and now participate in the consolidation and further development of the field of space medicine gathered at our round table. These participants were: Academician O.G. Gazenko, director of the Institute of Biomedical Problems of the USSR Ministry of Health; Professors N.N. Gukovskii and A.R. Kotovskaya, of that institute; V.G. Volovich, doctor of medicine, and also the cosmonaut physicians, B.B. Yegorich, doctor of medicine and Hero of the Soviet Union and O.Yu. At'kov, candidate in medical sciences and Hero of the Soviet Union.

O.G. Gazenko: "It was no accident that cosmonautics, as a new and worldwide area for human activity emerged at the time it did. The way was prepared by the achievements of science and technology which came before. By the beginning of the 1960s scientific knowledge and developments made it possible to seriously consider the possibility of human space flight. Medical specialists knew much about the conditions and influences which the first Earth man would encounter in space.

"In the 1950s a series of experiments was performed with high-altitude rockets using animals and other biological subjects. More than 50 dogs were flown on these rockets. A large amount of encouraging scientific data was collected, implying that higher animals were fully able to tolerate space flight conditions, including short periods of weightlessness.

"The most important step on the road to manned space flight was the research performed during the flight of the second artificial satellite and the satellite spacecraft. As early as the flight of the famous Layka on the second artificial satellite, placed in orbit on 3 November 1957, scientists obtained information, over the course of 7 days, about the behavior and functioning of animals exposed to longer periods of weightlessness. The 1-day flight of the dogs Belka and Strelka in August 1960 -- the first living creatures to fly in space and return to Earth safely -- had great significance, as well.

"On the threshold of Yu.A. Gagarin's flight in March 1961, animals successfully completed flights in space on the fourth and fifth satellite spacecraft which were highly similar to the upcoming first manned flight."

A.P. Kotovskaya: "The initial visit of the first 6 cosmonauts to the cosmodrome came just before the flight of Zvezdochka on the fifth satellite spacecraft. They were just in time to pick a name for the dog.

"We obtained the animals from the kennel and gave them the most diverse, but appropriate, names. For example, Mukha [fly] bore a real resemblance to a fly: small, pesky, nervous. She worked in our experiments for a long time. There was Markisa (Marquise) -- all white, and dignified. Layka's (Husky) ears stuck up. Chernushka (Blackie) was black all over. But there is a story about Zvezdochka's (Little Star) name. In the beginning we called her Udacha (good luck). But we sensed what close attention the cosmonauts paid to our work. And we realized that we had to change her name -- good luck is something fortuitous, something which happens by accident. But we were basing our work on the results of many years of research corroborated by experience. We asked the cosmonauts to think about it and they changed her name to Zvezdochka."

O.G. Gazenko: "This research was of great benefit to scientists in preparing for manned spaceflights, and answered many questions. At the same time, the answer to the main question was not completely clear: could a man complete a space flight and tolerate all the stress it involved? At that time there were quite a few scientists who asserted that man could not tolerate the state of weightlessness, and furthermore, that his psyche could not stand the terror that the vastness of space was sure to engender. Only manned flight itself could put all these doubts to rest."

A.R. Kotovskaya: "The first flight into space was preceded by an immense amount of work. Out of several thousand people, 20 were selected for the first contingent. They were dissimilar in appearance, behavior, and personality, although they were close in height, and in addition, had much in common. They were all young, all pilots, all were united by the desire to do whatever was required and the aspiration to complete their assigned program as well as possible. The main thing, and I want to emphasize this, is that they trusted us, the medical staff. At that time this was particularly important: after all there were many unanswered questions before us, and in many areas we were starting from scratch. We were the first to acknowledge this. After all, it was from them that we obtained new information which was to become the basis for the subsequent development of selection and training systems.

This group also contained Yu. A. Gagarin. He stands out in my memory by virtue of his open nature, sociability, friendliness, and desire to help. Each man in the contingent wanted to be the first [in space]. Each one knew that he was being graded for his performance on the various examinations and physical tests. And things did not go smoothly for everyone. For example, some people were better able than others to tolerate the centrifuge tests. When you see someone having trouble, there are a number of ways you can react. You can simply accept what has happened, or you can attempt to intercede. Gagarin chose the latter course. More than once he asked me to help someone who wasn't succeeding at something, to treat him with more sensitivity, to try it one more time. And this certainly made him stand out."

N.N. Gurovskiy: "And they had to go through major ordeals, high acceleration on the centrifuge and various stress tests and periods of

isolation in special anechoic chambers. Training in aircraft laboratories, helped them to become acquainted with the state of weightlessness, which is so alien to human beings. Ada Ravgatovna (Kotovskaya) was absolutely correct when she said that we started from scratch in many areas and, for this reason, many of the tests in the course of selection were, so to speak, unnecessarily 'hard'."

A.R. Kotovskaya: "The launch date approached. On 9 April, we performed a medical examination of the cosmonauts in the cosmodrome, the results of which were included in their records. Next came the meeting of the State Commission. We already had a feeling that Gagarin would be the one chosen to fly, so we were not terribly surprised when the decision was announced.

Yuriy Alekseyevich attempted to conceal his excitement and act nonchalant.

On the evening of 11 April there was a preflight examination during which we attached long-term electrodes. On the morning of the day of the flight, Gagarin underwent a short examination and was fitted into the space suit.

"And after that came the world's first manned space flight."

O.G. Gzenko: "The flight of Yuriy Gagarin answered the big question: man can indeed fly, can tolerate the stress of space. And in that respect, the first flight was a step into the unknown. It paved the first and main road into space for all who came after and are yet to come."

V.G. Volgovich: "It is not enough just to put a man into space. He must not be exposed to unnecessary danger. His safe return to Earth must be assured. Plans must be made to cope with the various emergencies which might arise. Unlike today's cosmonauts, in those days, Gagarin was to be ejected at an altitude of 7 kilometers and would land separately from the spacecraft. He had on a special suit, which he wore during the flight, as well as during landing. This suit would have saved him had the craft depressurized, along with protecting him from temperature extremes. Finally, the cosmonaut might have to land on water, instead of land. It was clear that, whoever else met the cosmonaut when he landed, a physician had to be there. Thus a group of physicians, able to use parachutes, as well as to provide the necessary medical care had to be found.

"A group of four such individuals was formed. Two of us are here today (nods in the direction of B.B. Egorov). We rode in first aid vehicles and learned to give emergency first aid. In the evenings we studied, and often went out to the Moscow airport for parachute training. Several days before launch we were dispersed to various possible landing points.

On the eve of the flight it rained hard all night. But towards morning the wind dispersed the clouds, and at around 8:00 it was deemed safe for the search planes to fly. I was lucky. Our plane turned out to be closest to the spot where Gagarin landed. Below us, we could see the orange spot of the enormous parachute. We prepared to jump. Suddenly the navigator emerged from the cabin and indicated with a gesture that the jump had been cancelled. Gagarin had landed safely, without incident, and did not require a physician's help. Furthermore, the wind was strong and there was a chance that the physicians could get hurt on landing.

"We were told to follow the helicopter in which the cosmonaut was riding. A little while later, on board an aircraft heading for Kuybyshev, I performed a medical examination on Gagarin. The first cosmonaut in the world was astonishingly calm: his pulse was 68 beats a minute, his blood pressure and temperature were normal. He joked, recalling the details of the flight, and responded readily to questions and comments.

"But when they started passing him notebooks, writing pads, or simply pieces of paper, he said, 'What am I, a movie star, to sign autographs?' But he nevertheless acceded to the persistent requests and signed what were, undoubtedly, the first autographs he had given in his life."

"During this relatively short flight, I found it difficult to believe that I was sitting next to a man who had just flown around the globe."

N.N. Gurovskiy: "I would like to add that, even at the peak of his worldwide fame, Yuriy Alekseyevich retained his marvelous character trait -- his sensitive, considerate treatment of people. And this, as you well know, is not always the case. I remember that even after his flight he found time to come the hospital where the potential cosmonauts had been selected and gave all the nurses and attendants his picture, inscribed with very warm words of gratitude for what they had done for him. This demonstrates that fame had not gone to his head. When he was asked, 'What is your biggest problem in life?' he answered, 'Struggling with fame.' And he emerged victorious from this struggle."

B.B. Yegorov: "Our search plane on that April day was on duty over Siberia, near where the Tunguskiy meteorite fell. If the third stage of the booster rocket had not functioned properly, there was a possibility of an emergency landing in this region. But, as you well know, everything went off without a hitch and we did not have to jump.

"We returned home. I remember that the weather was beautiful, there was rejoicing on the streets. We went around Moscow smiling, rejoicing along with everyone else. We were not supposed to say (although we wanted to very much) that we too had participated in this event."

O.G. Gazenko: "Several months later a second cosmonaut, German Stepanovich Titov, spent 25 hours in space. On this flight we were already dealing with the full spectrum of problems which man encounters in space. At the same time, this flight showed that man can not only tolerate a period of space flight, but can live and work in space. The observations and investigations which Titov performed enriched our knowledge and permitted us to develop our future space program.

"Gradually manned space flight picked up speed. The 'Vostok' craft were replaced by the multipassenger 'Voskhod,' and then by the 'Soyuz.' The number of people who had been in space increased.

"Our knowledge of space medicine was also enriched. We were already able to specify more fully the systems in the human body which are most strongly affected by weightlessness. It became evident that further increases in the duration of flights would require the development of countermeasures to prevent adverse effects.

"This was demonstrated particularly clearly after the 18-day flight of A. Nikolayev and V. Sevast'yanov (the duration record at that time) on the spacecraft 'Soyuz-9' in 1970. Their return to Earth's gravity after the flight was accompanied by unpleasant sensations, at first they had trouble walking, and muscle mass had decreased.

"It became clear that long-term flights require special exercise equipment, and a number of other devices on board the flight vehicles.

"Such devices were developed before the beginning of flights on the 'Salyut' orbital stations and these were improved as the duration of the flights gradually increased. Living conditions on board the orbital stations also were improved, as was the entire medical flight support system. All of this allowed us to implement a series of long-term flights, the longest of which lasted 237 days."

Moderator: "We have received letters to the editor asking us to describe how B.B. Yegorov and O.Yu. At'kov got to be cosmonauts, and to discuss the work they are doing today. In particular we have received such requests from K. Smirnova, a surgeon's assistant in Barnaula, and A. Bagirov, a physician in Baku, along with many others."

B.B. Yegorov: "I was a student at the First Moscow Medical Institute. From my elementary school days I had been interested in radio engineering. This hobby, as they now call it, required money. Therefore, I had to earn some. When I was in my last year of medical school, I heard that a new enterprise had been started which was hiring people with medical training.

"I remember they led me to a small room and put me to work as a lab technician. Later, I found out that they were working with the first contingent of cosmonauts. This was the beginning of the first training programs and medical examinations. If I had known then how this would all end...

"After I finished medical school, I continued to work there, doing research on the vestibular system.

"When they were planning flights on the 'Voskhod' spacecraft it was decided to send researchers into space -- an engineer and a physician. They formed a group of medical people whom they began to train for this flight, in which the medical effects of weightlessness would be assessed right there in space and medical research would be performed. When the decision was made about the flight, I was selected.

"Then back to the routine of life on Earth. My candidate's dissertation was based on the results of my work before and during the flight. Afterwards, I continued to work at the Institute of Biomedical Problems. I headed a division which was responsible for providing medical support for space flights, i.e., for the collection and analysis of medical information obtained during the flights. I defended my doctoral dissertation. Several years ago I was assigned to head the newly established Institute of Biomedical Technology."

O.Yu. At'kov: "I too was a student at the First Moscow Medical Institute and after I finished I was assigned to work at the A.L. Myasnikov

Institute of Cardiology (now part of the All-Union Cardiological Scientific Center of the USSR Academy of Medicine).

"Our center has had a long and successful history of collaboration with space medicine. Some of our young scientists were working toward the solution of certain problems in this area, in particular the study of the cardiovascular system using echocardiology, which was my speciality. To my great surprise, a year after we began collaborating I was asked to become a candidate for selection.

"I said nothing about this at home or at work. But during my vacation I appeared before the medical commission and, again to my surprise, I was pronounced fit.

"I well remember the centrifuge in which they rotated me. I felt like the whole world had shrunk down to the size of a penny and the top of my head began to pound like a drum.

"But, one after another, I jumped through all the hoops of the selection process. Seven years passed between that time and my flight. They were difficult years. We had both technological and purely human problems. We had to demonstrate our competence and each one tried to create the impression that he was just the person needed to do the job.

"In order to be a competent space physician, I had to review much and learn many things from the beginning -- for example, I couldn't get along without ophthalmology and dentistry and other disciplines. After all, in the event of unforeseen medical circumstances, I had to be able to help my comrades on the crew.

"An extensive scientific program also awaited us. In 237 days we performed more than 30 biomedical investigations and experiments, and many of them were repeated. Aside from this, I had other duties as a crew member.

"The flight was not easy. Here we are sitting around this table and chatting, we can hear the sounds from the street, over there on the table is a vase of flowers. And it's difficult to imagine what it's like to spend 8 months in an enclosed space."

Moderator: "Your crewmates L.D. Kisim and V.A. Solov'yev are now working in space on board the new 'Mir' orbital station."

O.Yu. At'kov: "I envy them. And at Baykonur when I was seeing them off I felt, and I still feel, as if I were being split in two. I passionately wish them successful completion of their flight program and safe return.

"I am continuing my analysis of the information obtained in our last flight. I hope that the results of our work in space will be useful not only for space medicine, but for medicine on Earth."

N.N. Gurovskii: "Yes, today we may say with confidence that cosmonautics has enriched our knowledge not only about space, but about Earth and about ourselves.

"First and foremost, our understanding of man has deepened. After all,

history has arranged things so that the attention of medical people has always been directed at sick people and how to cure them. Even today, as a rule, the people who go to see doctors are sick, rather than well. For this reason, contemporary medicine has more information about various diseases, their causes and cures, than about what it means to be a healthy human being.

"Our patients, in contrast, are healthy. Our systematic study of many of the physiological systems in the cosmonauts is helping to give us a better understanding of normal human physiology. Our understanding of the mechanisms underlying regulation of the cardiovascular system, of muscle tone and coordination, of fluid-electrolyte metabolism, of the structure and function of bone tissue, and of the function of the vestibular system has become more complete.

"The relative ease with which cosmonauts have accommodated to weightlessness, and then again to Earth's gravity demonstrates that humans have a great capacity to adapt.

"Much information that is useful to modern public health practice can be derived from results in the area of space psychology. There have already been examples of the use of the principles of psychological compatibility in the selection of members of various types of work groups -- crews for aircraft, polar stations, submarine laboratories, sports teams, and many groups in industry. In medicine, these include surgical teams, first aid crews, and resuscitation crews.

"Many methods and apparatuses developed for biomedical research in near-Earth orbit, are now being used successfully on Earth for mass prophylactic examinations, diagnostics and treatment. For example, the telemetric system for continuous monitoring of electrocardiograms is being used in cardiovascular clinics; various provocative stress tests are used for diagnosing a variety of diseases; the 'Tonus' device is used in the treatment of trauma to stimulate the muscles electrically in order to strengthen them. This list could be made much longer and it is constantly growing.

"The future holds promise for the utilization of space flight conditions for the manufacture of exceptionally pure drugs and medicine in quantities impossible to obtain on Earth. It would appear that, in time, enzymes, hormones, antibiotics and other medicinal preparations may be produced in weightlessness and used for the needs of public health on Earth.

"A process of mutual enrichment is occurring: terrestrial medicine has given and continues to give much to space medicine, while space medicine, in increasingly repaying its 'debts.'"

O.G. Gazenko: "Over the course of 25 years, 202 people have been in space. If the time spent in space had been logged during a single flight, it would have lasted more than 16 years. An immense amount of experience has been gained. But, as has always been the case, each new step into space must be weighed carefully and must be based on the most meticulous and detailed study of our entire current store of knowledge. After all, we are talking about human beings -- their health and safety.

"Further accumulation of medical and biological information should lead us

not only to a better definition of the role of man in space, but also to a deeper understanding of the possible complications and problems which he may encounter in future flights. In essence this implies a continual increase in flight safety.

"For this reason, at our current stage of development, biomedical research in space is an issue of primary importance, with both great scientific and great practical implications. There is still no shortage of complex problems which require solution to ensure progress along the road first paved by Yuriy Gagarin during those first 108 minutes in space."

SPECIAL FEATURE: INTERVIEW WITH DR. OLEG YUR'YEVICH AT'KOV

In Nedelya. 1360(16): 13; 1986. Interviewer: Andrey Ivakhnov.

"Oleg Yure'yevich, how would you prefer we refer to you these days, as a physician or a cosmonaut?"

"In other words, you are asking if I have become neither fish nor fowl. I hope that the answer is no. I am a physician and, to some extent, a cosmonaut. But I can't call myself a cosmonaut by profession; this would be presumptuous since professional cosmonauts devote their whole lives to this work. However, when you are in space, you cannot remain merely a physician, you need to make yourself useful so as not to remain merely a passenger."

"And what specifically did you do on the "Salyut-7" that was not medical work?"

"A spacecraft is not a hotel. One has to be able to look after a number of systems and to participate in the studies and experiments."

"Did you undergo the same training program for the flight as the other members of the crew?"

"Naturally there were some differences in our training. A researcher must study the systems of his station and ship which are in his sphere of responsibility. On the transport ship, I occupied the righthand seat: thus, I was responsible for the life support system, radiocommunications and television. I helped the captain with approach, docking and redocking operations. The entire biomedical sphere of influence was mine of course, but I was also in charge of some of the scientific apparatus, for example, instruments for photographing the Earth at various wave bands."

"How did you happen to be selected for the crew?"

"After I completed medical school, I worked at the Myasnikov Institute of Clinical Cardiology, which subsequently became a part of the Cardiological Center. In 1975, we participated in a study of the cardiovascular system of cosmonauts on long-term flights. Subsequently we continued to work with the space program. In 1976, I was asked to go before the selection committee. For physical reasons, I did not consider myself fit for this position, even though I had participated in sports, played on the Institute's hockey and volleyball teams, and was even rated. Nevertheless, when I was in school, I spent my time mainly on studying. In my second year, I became 'captivated' by cardiology. I studied in Kiev, and went off to Batyyeva Mountain where Nikolay Mikhaylovich Amosov was performing surgery. I became intrigued with medical cybernetics. The thought of becoming a space physician never entered my mind."

"Tell me the truth, were you frightened when you flew? How did you feel when the craft was launched?"

"Take-off and landing are very tense moments and no one can be unaffected. You not only want to survive, you want to acquit yourself honorably, so as to be able to look people in the eye afterwards. At the

moment of take-off my pulse was about 120: a typical response for a person encountering the unknown. I was constantly aware of the operation of the rockets at my back. During lift off, I felt some sort of vibration and looked over at the captain, but he was perfectly calm. Therefore, everything was 'routine' as our Denisych (Leonid Kisim) used to say. Volodya Solov'yev was also watching the captain at this moment. We felt one stage complete its work and then the next one. With every cell in our bodies we felt each second pass and waited for the five hundred and thirty or so seconds to pass, after which we would experience weightlessness."

"And when it came..?"

"There was such a complex mixture of sensations, that I don't know what to compare it with. It's as if you have just completed some very heavy work and haven't had time to rest and suddenly you're given an even harder job. You are in a constant state of mobilization and for a long period, too."

"Your crew was in space for almost eight months. How did you cope with being cut off from Earth, from your families?"

"The busier you are, the easier it is. Under stressful conditions, work makes life easier. It doesn't permit you -- I won't say to fall apart -- but to give yourself up to your emotions, which might subsequently lead to psychological debilitation, or depression. We kept on asking ground control to give us more work to do! There were good days and bad days, difficult and easy tasks, moments of joy and moments of sadness; but we never felt downhearted.

"A three-man team is a special case. When two people work together, things are harder because it is very difficult to maintain a balance. After all, we know that in life some people are leaders by nature. In space, there is only one captain, but this does not mean that he is always the leader."

"You mean that there is also an unofficial leader?"

"On long-term flights, leadership is not a fixed attribute. At different stages there are different leaders. No one can be perfectly competent in all areas. And in space competence is always being challenged and so is leadership. We didn't discuss this point and we didn't need to discuss it. The whole crew simply decided that we would do our work well. We even told ground control: don't make those decisions for us, don't tell us that this job is for the cosmonaut-researcher, this one for the flight engineer and this one for the captain; on this crew, we do everything as a team. It would happen that one of us would be busy with some 'clean' job, and another one would begin unobtrusively to work on one of the less pleasant, but essential tasks, for example, sanitation. He would get it finished and then the others would see that it was already done, and everyone would feel good."

"This harmonious team was forged from three very different people. How was this achieved?"

"Yes, we are very different, but this was an excellent thing. It would have been worse if we were very similar. It is important that people

learn to find points of agreement rather than disagreement, and only turn to a third party arbitrator as a last resort. However, being the third party arbitrator when the other two disagree is difficult too. You have to find points of agreement, and if you can't find any, you must not take sides."

"Did it ever happen that one of you took offense at a comrade?"

"Taking offense is a an impermissible luxury in space. We were united by our work and our respect for each other, both personal and professional. Each of us understood that all three of us had been selected for good reasons. After all, thousands and thousands of people on the Earth had given a great deal of time, energy, and sleepless nights so that we could perform this mission. This circumstance was decisive in preventing us from indulging in pride and personal likes and dislikes."

"What moments in the flight were particularly difficult?"

"One instance was the moment when we closed the airlock behind the first visiting crew. The visiting crews reminded us of the saying about beloved houseguests. You rejoice twice: once when they arrive and again when they go home (I am joking of course). When the first visiting crew left, we closed the airlocks behind them and, in the first few hours, scarcely exchanged a word. Then we obtained "acknowledgement" from Earth that they had landed safely and without incident. Exhaustion immediately overcame us. Each one thought, they are already home, they can take a real bath and eat real borsht, 'clinking the spoon against the bowl,' as our flight engineer put it. And we still had a half year to go before we would experience any of this. When the second crew, Vladimir Dzhanibek, Svetlana Savitskaya, and Igor' Volk left, things were quite different. We had only a short time longer to be in space, two months. And we saw them off with the words: "When you leave your hot bath tell them to start preparing our feast, we'll be home soon."

"Many amusing things happened as well. On one of our bath days, we decided to cut our hair. We had been given written instructions on how to do this. I said: 'Men, I remember how this was done, and I'm sure I can do the same thing myself.' I immediately gained status in their eyes. I cut the captain's hair and then the engineer's, they were very pleased and offered to split the task of cutting my hair: the captain would do one side of my head, the engineer the other. I was very touched by their offer, but said that they would undoubtedly have different tonsorial styles and that therefore it would be better if only one cut my hair."

"What did you do for recreation?"

"The issue of recreation is highly individual and highly specific. One man's meat is another man's poison. Everything had to be in place ahead of time and intended for a particular crewmember. The artists who entertained us did not always make our lives easier. For example one popular singer came on and said: 'Oh! How I would like to make friends with the cosmonauts! Right now, I'll sing you three songs and then I have to run, because at three on the dot I have to give a concert in the Hall of Columns. When you return, invite me to Star City and I will come and sing for all the cosmonauts..' It was very flattering that he wanted to

make friends with the cosmonauts, and it was quite an honor for us that he agreed to sing us three songs before running off to his concert. But maybe he shouldn't have come, since he was so busy.

"We remember many of our guests with gratitude: Mikhail Nozhkin, Robert Rozhdestvenskiy, the cast of the film 'Cruel Romance.' It happened that they could see us on the telemonitor and we couldn't see them, but they didn't know this. El'dar Ryasonov told us: 'Our beautiful star, who is still a student will sing you a song from the film.' Denisych asks us: 'Fellows, how does she look?' 'How should we know..' -- 'Well, smile anyway, you wouldn't want her to think that she didn't appeal to us.' It was a good encounter, we enjoyed their company and they enjoyed ours. In space, for some reason, you feel and sense everything more keenly. Not only what is said to you, but how it is said. We got a clear sense of whether people really enjoyed our company or whether they were simply doing a job, providing recreation for the cosmonauts."

"How did you cope with your separation from your families?"

"Our families were essentially in space with us. Especially our wives. They were on the ground, but it was no less difficult for them than it was for us. They had their own day-to-day problems, as well as anxieties related to the fact that their husbands were out in space. When we returned, we saw that they had developed grey hairs and crowsfeet."

"How would you evaluate your space flight overall?"

"Every flight adds a brick to the foundation of our knowledge of the unknown -- about space, about the capacities of the body, and about who we are on Earth, why we are alive. We too contributed our brick. I did what I could in the area of medicine; my comrades did what they could, for example, in the area of understanding of EVAs, and space commercialization. We travelled 160 million kilometers; others will fly farther. We did what we could to make it just slightly easier for them than it was for us."

"And from the point of view of our concerns here on Earth?"

"A portion of the apparatus, which was developed for space, may be adapted to needs on Earth. For example, the inboard echocardiograph 'Argument'; I feel that it has been neglected undeservedly in our press. More has been published about the Soviet-French experiment and the 'Ekhograf' device developed by French specialists. 'Argument' was developed in space before the French instrument. Using it, for the first time ever, we obtained a representation of a beating human heart. It has been put into mass production and will be produced for use by hospitals, clinics and polyclinics. We are modifying this instrument so it can be used by first aid crews. This is one of the examples of how space reimburses Earth for the expenses involved in its assimilation.

"Experiments were performed on the station concerning the permeability of living cells by calcium. It is well known that the loss of calcium from the body is a major medical problem, on Earth as well as in space. The experiments which we performed in orbit permit us to approach the solution of this problem on Earth."

"How does the Earth look from space? Did you see anything surprising?"

"During the flight we were fortunate enough to observe all four seasons of the year. The results of human activity are very easy to see. When the snow melted, we could see the squares of plowed fields, then growth appeared on them. The harvest matured and was gathered, then signs of plowing again appeared. Then the winter growth was covered in a blanket of snow.

"But we also saw pictures which we would have preferred not to see: night flashes, and explosions. I guess these were aircraft bombs or missiles. We saw an oil storage ship destroyed in the Persian Gulf. The plume of smoke spread over a thousand kilometers, you could see the wind blowing it this way and that. We observed this at the beginning of the flight and when we landed it was still burning.

And I saw something else of a completely different nature. One night I couldn't sleep and I propelled myself into the connecting compartment when suddenly I saw through the porthole that the planet had a luminous halo. Evidently, this was a reflection of the northern lights. I saw this but a single time. The next night I sat with my eyes glued to the porthole, but the phenomenon did not re-occur.

"Our planet is alive. And we must preserve it that way -- for our children and grandchildren, for all the generations to come."

"What kind of a person are you? What are your hobbies and interests?"

"An ordinary person. When we were in space, I missed the forest terribly, I wanted to bathe in the river, to swim. I don't mean that I'm a swimmer or naturalist. But for a long time, I have taken my vacation with my friends in a tent on the Volga, it's a tradition. These are friends from my student days; we try to schedule our vacations at the same time. We fish, and pick berries and mushrooms. We know where to find the clay to construct a smoker oven. But duty always calls. Ten days, two weeks at most, can I permit myself such a sweet life..."

"How do you feel about the number 13?"

"I live in apartment number 13, my daughter was born on 13 April. My crew left for the 'Mir' station on the 13th. It's a lucky number."

"By the way, when they were leaving, the 'Mayak' crew told the press that you would remain a member of the crew, only you would perform your assigned tasks on the ground."

"I did not merely go to the cosmodrome to see them off. Again and again I confronted with them those difficult medical situations which arose during the flight. After take off, I was in radio communication with them to tell them how things were at home, and to find out whether there was something I could send them on the transport ship. I listen to the communications sessions, not to what they say so much as how they say it. This is enough to tell me what kind of mood and state they are in. I intend to continue to do my small part."

CURRENT TRANSLATED SOVIET LIFE SCIENCE MATERIALS AVAILABLE TO OUR
READERS

Translations of recent Soviet publications, including those of interest to specialists in space life sciences, are published by Joint Publications Research Service (JPRS). JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. The phone number of NTIS is (703)-487-4600 and telephone orders are encouraged. Each individual issue of a JPRS report must be ordered separately. Prices depend on number of pages; a recent issue of Space Biology and Aerospace Medicine, for example, cost \$16.00. When ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited. An order takes 9-30 days to arrive. Rush orders are possible, but involve an additional charge. There is a significant and variable lag period between the time a JPRS publication is completed and the time it is orderable from NTIS.

Two JPRS USSR Report Series appear of particular interest to NASA life scientists. These are: 1) Space, and 2) Life Sciences: Biomedical and Behavioral Sciences. In addition, JPRS translates the entire issue of the bimonthly Space Biology and Aerospace Medicine. As a service to our readers we will regularly provide publication information for these reports and cite the titles of articles selected as particularly relevant to NASA. Translations of titles are those of JPRS. JPRS entries marked with * were previously abstracted in this Digest.

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-006 18 April 1986

Selected Contents:

Effects of Experimental Hypokinesia in Rats on Metabolism of Skeletal Muscle Proteins (Kazaryn VA; Journal Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-007 23 April 1986

Selected Contents:

c-AMP-Dependent Mechanisms of Relaxation of Vascular Smooth Muscle Cells in Hypoxia Not Related to Decreasing Concentration of Ca^{2+} in Myoplasm (Solov'yev AI; Journal Article Abstract; 1 page)

Effects of Immunoglobulins on Work Performance of Irradiated Animals (Arlashchenko NI, et al; Journal Article Abstract; 1 page)

Repair of Gamma-Radiation-Induced Single-Strand Breaks in DNA in Myxomycete

Physarum Polycephalum

(Gushcha NI, et al.; Journal Article Abstract; 1 page)

Induction of Tumors in Animals Irradiated with Fast Neurons at Various Energies

(Pinchuk VG, et al.; Journal Article Abstract; 1 page)

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-008 9 May 1986

Selected Contents:

Lactobacteria and Prophylaxis in Space

(Ivanov I; Newspaper Article; 1 page)

Commentary on Results of Biological Satellite Program

(Fabbishenko Yu; Journal Article Abstract; 1 page)

Conditions of Biotransformation of Straw into Protein Product by Mycelial Fungi

(Babitskaya VG, et al.; Journal Article Abstract; 1 page)

Sweating Reflex in Complex of Methods for Evaluating Operator Efficiency

(Slynko PP; Journal Article Abstract; 1 page)

Radioprotective Properties of 3-Mercaptoindole Derivatives

(Skvortsova GG et al.; Journal Article Abstract; 1 page)

Antihypoxic Effect of Dioxindole Derivatives

(Mazhilis LY, et al.; Journal Article Abstract; 1 page)

Influence of Shipboard Environmental Factors on Conditioned Reflex Activity of Experimental Animals During a Long Voyage

(Netudykhatka, O.Y., et al, Journal Article Abstract: 1 page)

USSR REPORT: LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES

JPRS-UBB-86-010 23 May 1986

Selected Contents:

New Biopolymer Separation, Electrophoresis Equipment Reported

(No author cited; Journal Article; 1 page)

Critical Levels of Long-Term Global Racemizing Factors of Biosphere

(Avetisov VA, et al.; Journal Article Abstract; 1 page)

Normalization of Dystrophic Brain Neurons of Rats After Hypoxia and Transplantation of Embryonic Nerve Tissue

(Polezhayev LV, et al.; Journal Article Abstract; 1 page)

ENGLISH TRANSLATIONS OF SOVIET SPACE LIFE SCIENCES BOOK AVAILABLE TO OUR
READERS

We have recently learned of a translation of a Russian book in space life sciences which is, or soon will be, available. For further information, NASA personnel should contact: NASA Headquarters, Scientific and Technical Information Branch (Code NIT-4), at (202) 453-2912. Other readers should direct inquiries to:

Mrs. Ildiko Nowak, Chief
The National Translation Center
The John Crerar Library of the University of Chicago
5730 South Ellis Avenue
Chicago, Illinois, 60637
(312) 962-7060

This book is:

Khachatur'yants LS and Khrunov YeV.

Conquering Weightlessness.

Moscow: Znaniye; 1985.

[99 pages; 7 references; none in English; No tables or figures]

NB: This is a popularized, rather than technical book.

NASA TM ON US-USSR COOPERATIVE SPACE BIOLOGY RESEARCH

Researchers interested in NASA Technical Memorandum 88223: **Final Reports of U.S. Monkey and Rat Experiments Flown on the Soviet Satellite Cosmos 1514**, by Richard C. Mains and Edward W. Gomersall, should contact Chris Schatte, Mail Stop 240A-3, Ames Research Center, Moffett Field, CA 94035. This is a non-classified report for unlimited distribution. Chapter titles of this report are listed below:

Cosmos 1514 Mission Description

U.S. Bioinstrumentation on Cosmos 1514

Synchronization of Primate Circadian Rhythms in Space

Cardiovascular Results from a Rhesus Monkey Flown Aboard the Cosmos 1514
Spaceflight, and Ground-Based Controls

Calcium Metabolism and Correlated Endocrine Measurements in Primates
during Cosmos '83

Early Postnatal Development of Rats Exposed in Utero to Microgravity

Developmental Morphology of the Eye, Vestibular System and Brain in 18-Day
Fetal and Newborn Rats Exposed in Utero to Null Gravity During the Flight
of Cosmos 1514

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16. Abstract This is the seventh issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 29 papers recently published in Russian language periodicals and bound collections and of 8 new Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. Additional features include two interviews with the Soviet Union's cosmonaut physicians and others knowledgeable about the Soviet space program. The topics discussed at a Soviet conference on problems in space psychology are summarized. Information about English translations of Soviet materials available to readers is provided. The topics covered in this issue have been identified as relevant to 29 areas of aerospace medicine and space biology. These areas are adaptation, biospherics, body fluids, botany, cardiovascular and respiratory systems, developmental biology, endocrinology, enzymology, exobiology, genetics, habitability and environment effects, hematology, human performance, immunology, life support systems, mathematical modeling, metabolism, microbiology, morphology and cytology, musculoskeletal system, neurophysiology, nutrition, perception, personnel selection, psychology, radiobiology, and space medicine.					
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